Water Quality Restoration Plan

Umpqua Basin
Little River Watershed

Roseburg District BLM
Umpqua National Forest

February, 2001

Statement of Purpose

This water quality restoration plan is prepared to meet the requirements of Section 303(d) of the 1972 Federal Clean Water Act.

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A. Introduction

Little River Watershed

The area covered by this plan includes all lands within the Little River Watershed managed by the Umpqua National Forest (USFS) and the Bureau of Land Management, Roseburg District (BLM). The federal lands within the watershed comprise the Little River Adaptive Management Area (AMA), one of ten AMA's throughout the Pacific Northwest. AMA's were designated by the Northwest Forest Plan (NWFP) as places to encourage the development and testing of technical and social approaches to achieving the ecological, economic, and other social objectives as described in the NWFP. The specific emphasis of the Little River AMA is the development and testing of approaches to integration of intensive timber production with restoration and maintenance of high quality riparian habitat.

Watershed at a Glance	
Watershed	Little River (131, 853 acres; 206 mi^2) USFS Managed (63,575 acres) BLM Managed (19,802 acres) Private Ownership (44,772 acres)
Stream Miles	Total (741 Miles) Public Ownership (410 Miles) Private Ownership (331 Miles) Perennial (168 Miles) Public Ownership (91 Miles) Private Ownership (77 Miles)
Watershed Identifier	1710030111 (Hydrologic Unit Code)
303 (d) Listed Parameters	Temperature, pH, Sediment, Habitat Modification
Beneficial Uses (per Oregon's 303d Listing Criteria)	Resident Fish & Aquatic Life, Salmonid Fish Spawning & Rearing, Water Contact Recreation

Figure 1. Little River watershed statistics. Stream miles taken from latest BLM stream data.

In general terms, a watershed can be defined as any bounding area where water drains to a specified outlet. To better classify watersheds they are commonly divided into size categories called fields. The largest classification of this kind is termed a 1st field watershed (also called a Region). As part of the ranking system, 1st fields break down into smaller 2nd fields (Sub-Regions) which then can be broken into 3rd fields (Basins) and then 4th fields (Sub-Basins). Recently, there has been a need to further divide into smaller units. As a general rule, each 4th field is subdivided into roughly 5 to 15 new units called 5th fields (Watersheds). A typical size for this watershed drainage area is from 40,000 to 250,000 acres. The typical size of a 6th fields unit (Sub-watershed), a subdivision of a watershed, is 10,000 to 40,000 acres. Little River is a 5th field watershed and it has been divided into 13 6th field sub-watersheds. This document uses the terms watershed and sub-watershed to describe these 5th and 6th field units.

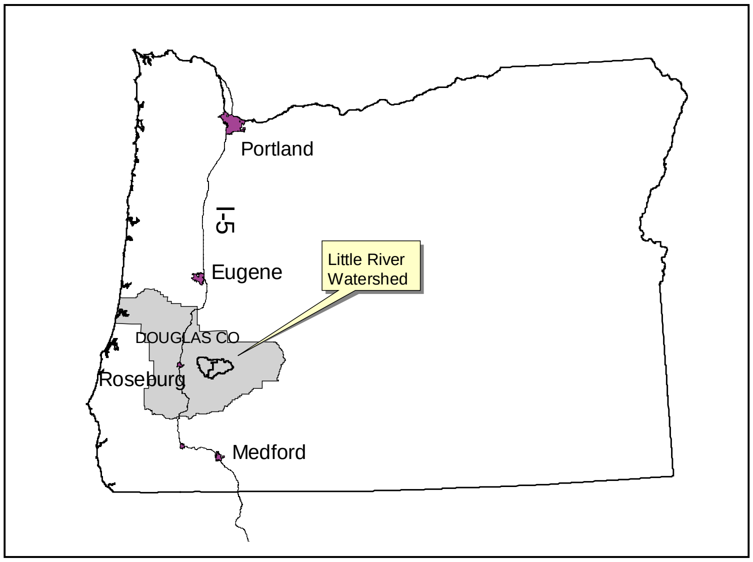

Figure 2. Location of Little River watershed.

Listing Status

Little River and several tributaries have been placed on the Oregon 303(d) list due to documented violations of water quality standards (DEQ 1998). Figures 3 through 5 show the listed parameters, locations, beneficial uses and extent of the listings. The listed parameters encompass 55 miles. This is 7% of the total streams and 21% of perennial streams.

Location	Parameter(s)
Black Creek, (mouth to headwaters)	Rearing Temperature
Cavitt Creek (mouth to headwaters)	Rearing Temperature
Cavitt Creek, (mouth to Evarts)	pH
Cavitt Creek, (mouth to Plusfour Creek)	Sediment, Habitat Modification
Clover Creek, (mouth to headwaters)	Rearing Temperature
Eggleston Creek, (mouth to headwaters)	Rearing Temperature
Emile Creek, (mouth to river mile 1.0)	pH
Emile Creek, (mouth to headwaters)	Rearing Temperature
Flat Rock Creek, (mouth to headwaters)	Rearing Temperature
Jim Creek, (mouth to river mile 2.0)	Rearing Temperature
Little River, (mouth to Hemlock Creek)	Rearing Temperature, Sediment, Habitat Modification
Little River, (Hemlock Creek to headwaters)	Sediment, Habitat Modification
Little River, (mouth to White Creek)	pH
Wolf Creek, (mouth to headwaters)	Rearing Temperature
Wolf Creek, (mouth to major falls)	pH

Figure 3. Streams within the Little River watershed that do not meet State water quality standards (1998).

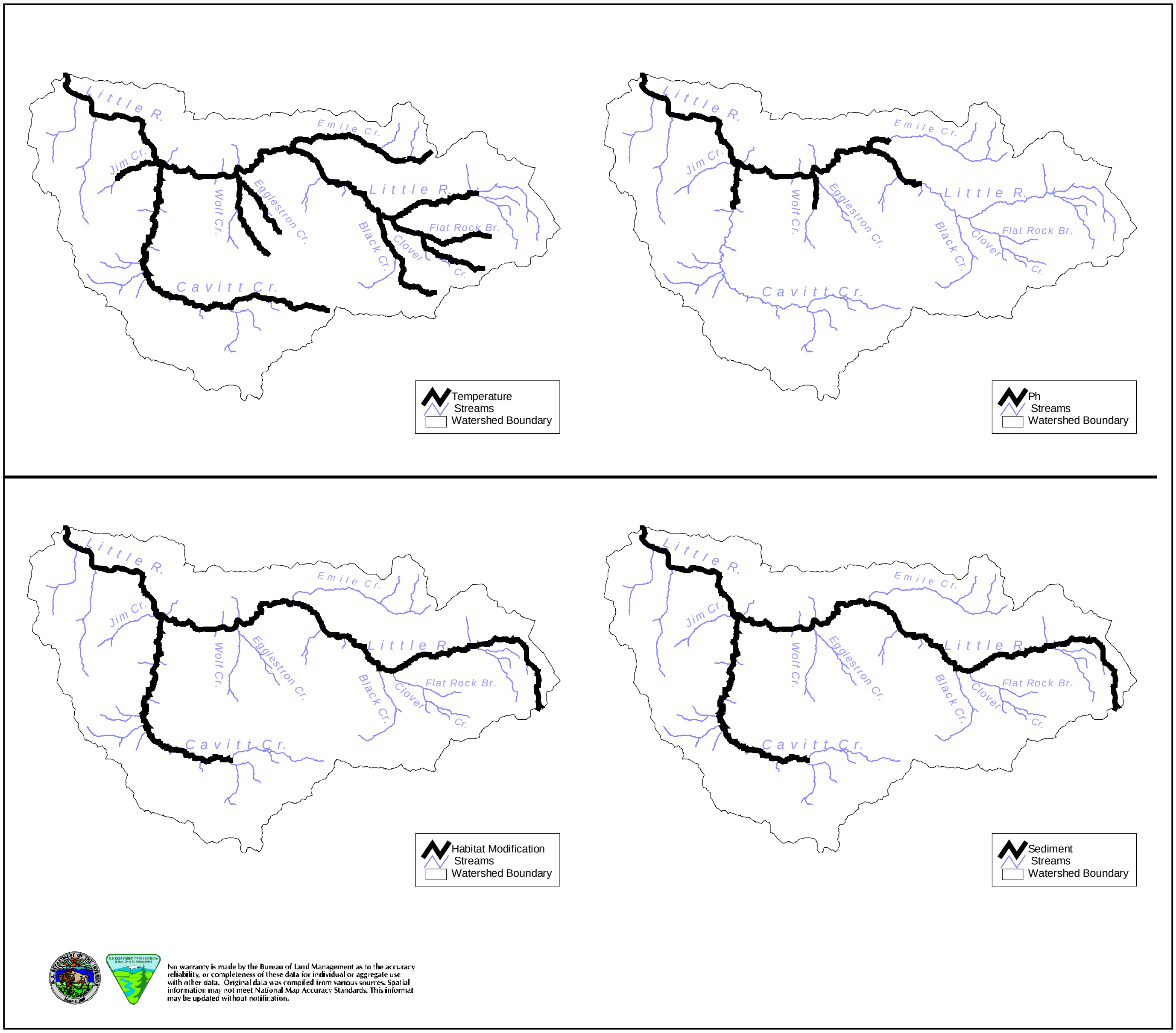

Figure 4. Little River watershed, 303(d) listed streams.

Based on the large numbers of juvenile anadromous salmonids leaving Little River, this system is an important tributary to the North Umpqua River for spawning and rearing habitat. Stream surveys indicate that 48 miles of streams in the watershed support anadromous species, primarily in the larger, main stem of Little River and Cavitt Creek. Anadromous fish distribution is often limited by waterfalls or steep gradient cascades in tributaries.

Resident, or non-anadromous trout also occur naturally (rainbow and cutthroat) or have been introduced for recreational purposes (brook trout and kokanee). Several other species of introduced game fish also inhabit the Little River system, as do numerous native non-game species. Various species of amphibians and reptiles occur in the watershed including sensitive species such as the tailed frog, red-legged frog, yellow-legged frog, cascade frog, southern torrent salamander, and western pond turtle (Little River Watershed Analysis 1995).

Resident Fish & Aquatic Life	<u>Anadromous Fish:</u> Spring chinook, fall chinook, coho (t), summer and winter steelhead trout (c), sea-run cutthroat trout (c), Pacific lamprey (co) <u>Resident Fish:</u> Rainbow trout, cutthroat trout (c), brook trout (n), kokanee salmon (n), and numerous other non-game species <u>Other Aquatic Life</u>: tailed-frog (s), yellow-legged frog (s), red-legged frog (s), pacific giant salamander, cascade frog (s), southern torrent salamander (s), Dunn's salamander, western pond turtle (s), beaver, river otter, and numerous other species of frogs, salamanders, turtles, & snakes
Salmonid Spawning & Rearing	Spring chinook, fall chinook, coho , summer and winter steelhead trout, sea-run cutthroat trout, Pacific lamprey
Water Contact Recreation	Swimming, rafting, fishing in ponds/lakes

Figure 5. Beneficial uses in the Little River watershed. Federal ESA designation noted as (t) = threatened; (c) = candidate; (co) = species of concern; (s) = sensitive, and (n) = non-native.

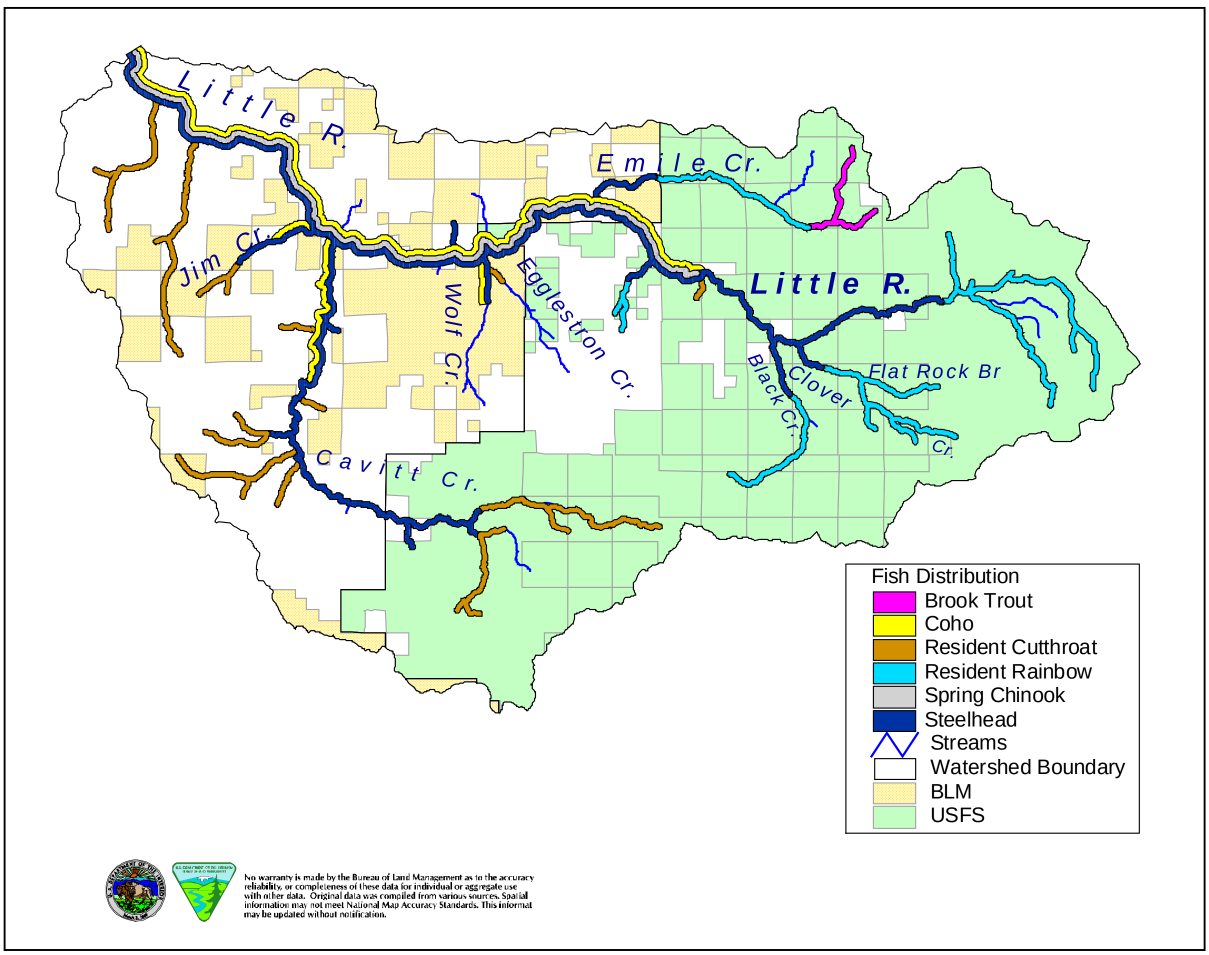

Figure 6. Fish Distribution in the Little River watershed.

The primary elements that are likely limiting fish populations within the basin are high water temperature during the summer, excess fine sediment, extensive areas of oversimplified habitat, and increased peak flows (Watershed Analysis 1995). When considered separately, it is not likely that each of these attributes could solely be responsible for degraded aquatic habitat conditions for fish species. However, when considered cumulatively, all these factors add up to an aquatic environment that is applying stress to populations of aquatic organisms. It is well known that acute or chronic stress approaching or exceeding the physiological tolerance limits of individual fish will impair reproductive success, growth, resistance to disease, and survival (Schreck and Moyle 1990).

Watershed Characteristics
The Little River watershed is located approximately 18 miles east of Roseburg, Oregon, and encompasses 131,853 acres (206 square miles). The watershed lies within the Umpqua Basin (Figure 7). Much of the watershed lies within the western Cascades geologic province (83%), while the Klamath and Coast Range geologic provinces account for 11% and 6% of the watershed, respectively (Little River Watershed Analysis 1995). Elevations within the watershed range between 750 feet (225 meters) at the confluence with the North Umpqua River, to 5,275 feet (1,600 meters) at the headwaters.

High elevations receive over 80 inches of annual precipitation (rainfall equivalent), much of which accumulates as snow at elevations above 2,000 feet. Lower elevations average 40 inches of rainfall annually. The timing of precipitation in the Little River watershed can be separated into a winter season of frequent storm events and a long period of summer drought. The watershed analysis provides a description of typical and peak flows. In late summer, low flows in Little River averaged 25 cubic feet per second (cfs) between 1954 and 1987 at the Peel gauging station located 6.3 miles up from the mouth of Little River. During the same period, winter base flows were typically in the range of 200 to 300 cfs, with flood peaks measured as 22,700 cfs in 1955 (Little River's flood of record), 21,100 cfs in 1956, and 20,900 cfs in 1964. Peak flows have typically varied between 5000 and 15,000 cfs during this period. Rain-on-snow events can potentially trigger high winter and early spring peak flows in Little River.

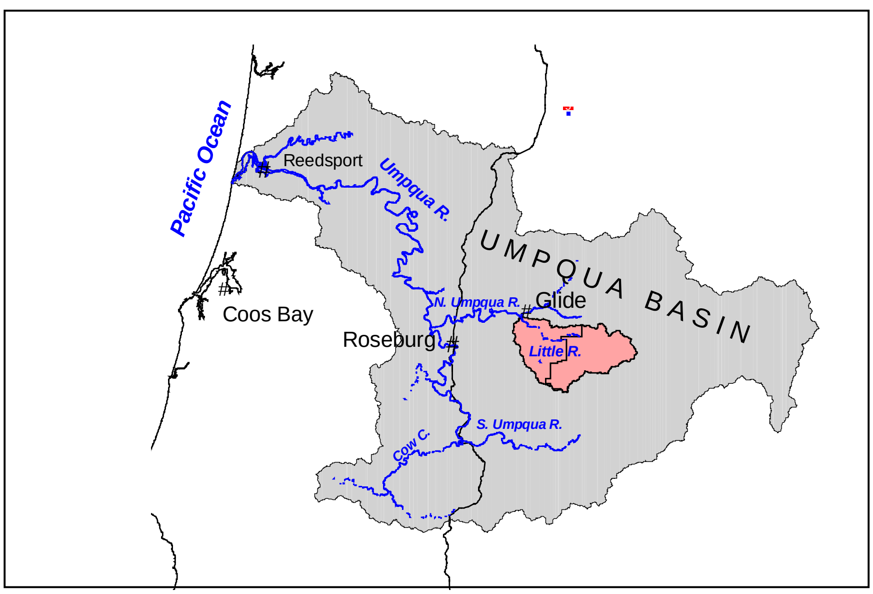

Figure 7. Umpqua basin and the Little River watershed.

The approximate length of the Little River is 26 miles from mouth to headwaters. The watershed has a drainage density of 3.6-mi./square mi.. Figure 8 depicts streams miles by stream order (Strahler 1957). There are various methods for deriving stream order, but all are intended to be measures of the position of a stream in the hierarchy of tributaries within a watershed. First order streams have no adjoining tributaries, while second order streams are formed by the intersection of two first order streams. Stream order helps describe: 1). Stream size and position in the watershed, and 2.) The amount of suitable stream substrate for spawning which varies with the size of stream (order) and salmonid species (Boehne and House 1983). The amount of spawning gravel per kilometer of stream is greatest in 4th order coastal watersheds and 5th order Cascade Range watersheds. The stream miles and orders shown in Figure 8 provide a general representation of the stream system in Little River; however, they were derived from GIS stream layers and have varying degrees of accuracy and completeness.

Sub-watershed	**Acres**	**Stream Miles**	**Stream Order**					
			(Intermittent)		(Perennial)			
			1	2	3	4	5	6
Black Creek	9,660	48	26	11	8	3	0	0
Clover Creek	7,395	34	19	8	5	2	0	0
Cultus Creek	7,751	37	20	9	5	2	0	0
Emile Creek	8,714	35	19	10	6	1	0	0
Little River Canyon	7,714	39	21	8	4	1	5	0
Lower Cavitt Creek	9,025	61	33	14	6	2	0	6
Middle Cavitt Creek	14,129	104	54	27	11	5	7	1
Middle Little River	13,052	56	33	9	7	0	6	0
Red Butte	10,810	58	29	17	4	1	8	0
Upper Cavitt Creek	6,795	33	16	7	8	2	0	0
Upper Little River	7,535	39	21	9	5	3	0	0
Watson Mountain	21,741	156	85	34	16	10	5	7
Wolf Creek	7,530	41	22	10	5	3	0	0
Totals	**131,851**	**741**	**398**	**173**	**90**	**35**	**31**	**14**

Figure 8. Miles of total streams and miles of streams by stream order in Little River by sub-watershed.

Of the 741 miles of streams in the watershed, approximately 3/4 are 1st or 2nd order streams. Many 1st and 2nd order streams do not flow continuously by late summer. Some 2nd order and all 3rd order and greater streams ordinarily flow year-round and are termed perennial.

Land Use and Ownership

Historically, the old growth forests of the western edge of the Cascade Range met the eastern edge of the mixed hardwoods, prairies and conifers of the Umpqua Valley hills. The Little River watershed consists largely of coniferous forests situated in the upper and middle reaches, with mixed hardwood and coniferous forests and prairies in the lower portion of the watershed.

The U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) administer 63% of lands within the Little River watershed (Figures 9 & 10). USFS lands are mostly large, intact blocks, while BLM lands are mostly patchwork in nature (sections/partial sections surrounded by private land). The remaining 37% of the land consists of private lands, much of which is managed as industrial forest. Timber production is the dominant land use activity in the Little River watershed.

	Sub-watershed												
	Black Creek	Clover Creek	Cultus Creek	Emile Creek	Little River Canyon	Lower Cavitt Creek	Middle Cavitt Creek	Middle Little River	Red Butte	Upper Cavitt Creek	Upper Little River	Watson Mtn	Wolf Creek
% Federal Land	97	100	99	84	97	34	29	57	49	96	100	23	62

Figure 9. Percentage of Federal land in Little River. Sixty-three percent of the Little River watershed is under federal jurisdiction.

The present condition, composition and age of the vegetation are largely the result of the widespread harvesting and replanting that has occurred since the 1950 s. To date, nearly 60% of the watershed has been harvested and replanted. Timber operations involve a number of activities, which can contribute to non-point source pollution. These current or past activities includes road building, timber harvest, log removal in streams, burning, and fertilization.

In 1994, public lands in the watershed were designated an Adaptive Management Area (AMA) under the Northwest Forest Plan (NWFP). The special emphasis for the Little River AMA is the development and testing of approaches to integration of intensive timber production with restoration and maintenance of high quality riparian habitat.

Other land use activities within the Little River watershed include rural residential development, water withdrawal, agriculture, and recreation. Approximately 1,200 people reside in the watershed, translating to a population density of 6 people per square mile. The majority of the people who live in the Little River watershed ranch and farm in the lower portions of the watershed. Latest records show 111 domestic water rights and 109 irrigation rights in the Little River watershed (Water Master, Douglas County). Due to the close proximity to Roseburg, Oregon, and the wide range of quality outdoor activities offered, Little River and its tributaries are a destination for many forms of recreation, including fishing (in ponds), hunting, swimming, hiking, and driving for pleasure. Roads and stream crossings distributed throughout the watershed provide vehicle access to managed forestlands, residences, and recreational areas.

Watershed Analysis

Watershed analyses are a required component of the Aquatic Conservation Strategy (ACS) under the Northwest Forest Plan (NWFP). The Record of Decision (ROD) for the NWFP was signed in April, 1994. A watershed analysis for the Little River watershed was completed in September, 1995. This WQRP tiers to and appends that document. The analysis and recommendations found in this WQRP uses data from the watershed analysis. Additional analysis and recommendations have been included where data was incomplete or new information was available. Figure 11 provides a summary of watershed conditions.

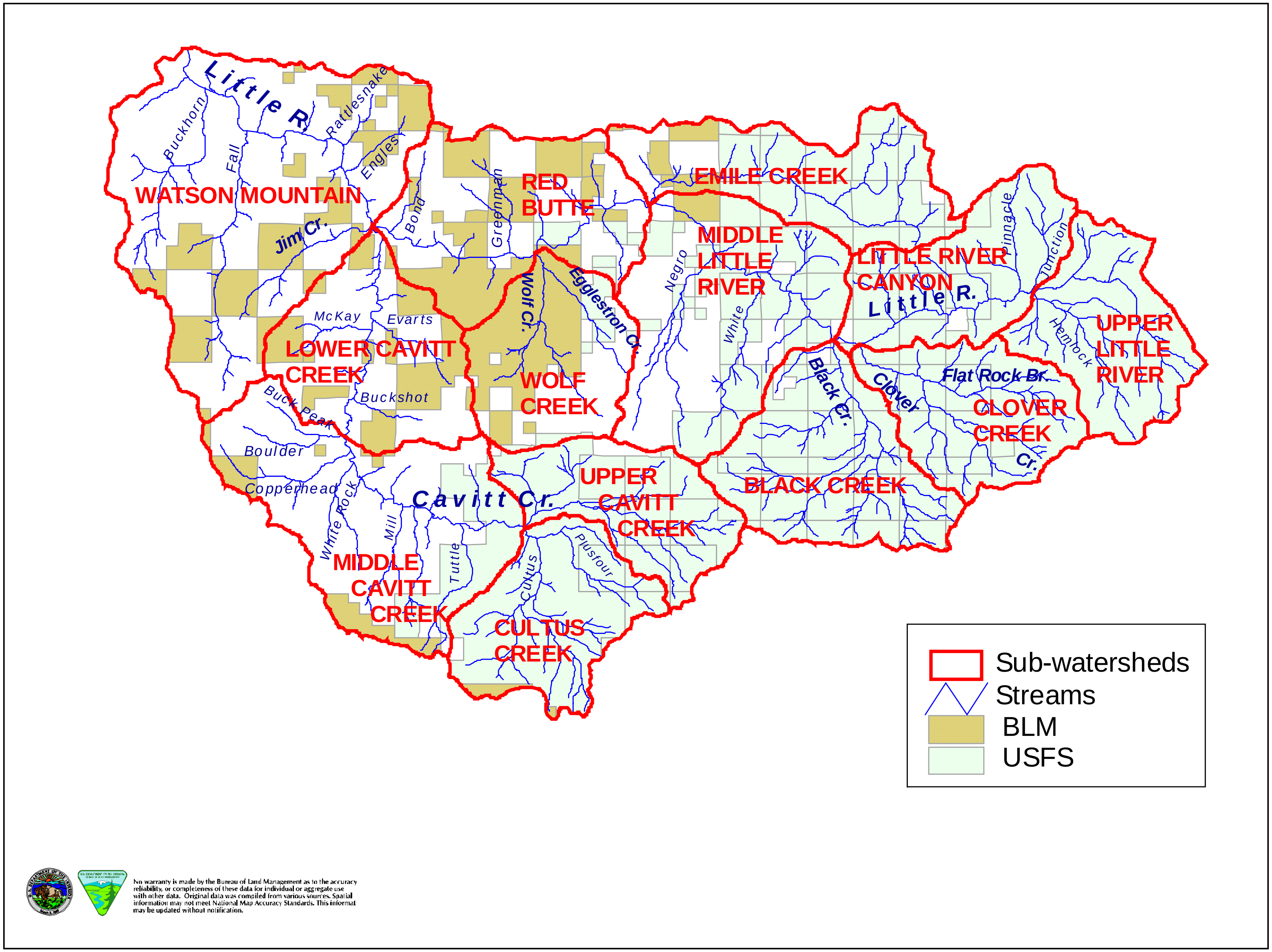

Figure 10. Reference Map of the Little River watershed.

Riparian Vegetation*	
Historical Condition	• Late seral vegetation dominant
Present Condition	• Early to mid seral vegetation dominant • 46% of forest along perennial streams clear-cut harvested • 62% of forest along intermittent streams clear-cut harvested • 90% of wide valley, low gradient riparian areas (Cavitt Creek and Little River) in degraded condition • Large portion of narrow valley, steep gradient riparian areas in degraded condition, riparian salvage and hi-grading common along valley bottoms
Forest Health & Productivity	
Historical Condition	• Frequent, low intensity fires maintained low fuel levels and open under-story
Present Condition	• Fire exclusion resulting in high fuels • Insect populations (mtn. pine beetle) above epidemic levels threaten pine health • Much of harvested lands are densely planted and overstocked (increased competition) • Soil compaction due to tractor harvest
Large Woody Debris	
Historical Condition	• Little or no information is available, reference areas indicate frequent large wood accumulations in the active channel (wood densities of 50 to 100 pieces per mile have been documented in unmanaged streams)
Present Condition	• Many stream sections have little to no large wood • Poor large wood recruitment due to streamside harvest & fire exclusion • Stream crossings disrupt transport of wood and sediment • Stream cleaning has decreased retention of large wood in the active channel (75% of fish bearing streams have been subject to stream cleanout)
Roads	
Historic Condition	• Few roads before industrial timber harvesting began in the early 1950's
Present Condition	• High road density (4.6 mi/mi^2) • Road placement often occurs in riparian areas • High number of stream crossings with many culverts undersized for 100 yr. flood • Stream network extension (due to ditch lines) increases winter peak flows
Flow Regime	
Historic Condition	• Little or no information is available, reference areas such as Boulder Creek indicate that peak flows were lower in magnitude and frequency
Present Condition	• Winter peak flows possibly increased by roads and harvest

Figure 11. Summary of watershed conditions (Little River Watershed Analysis, 1995). *Riparian areas are NWFP ROD buffers applied to the entire watershed for watershed analysis.

B. Temperature

Introduction

For stream temperature, the affected beneficial uses are resident fish & aquatic life and salmonid fish spawning & rearing. Salmonid fish species require specific water temperatures at various stages of their fresh water life:

Life Stage:	Spring Chinook:	Coho:	Cutthroat	Steelhead
Egg Incubation	42.1ºF to 55.0ºF	39.9ºF to 55.9ºF	40°F - 57°F	40°F – 57°F
Juvenile Rearing	50.0ºF to 58.6ºF	53.2ºF to 58.3ºF	49°F - 55°F	45°F – 58°F
Adult Migration	37.9ºF to 55.9ºF	45.0ºF to 60.1ºF	37°F - 68°F	37°F – 68°F
Spawning	42.1ºF to 55.0ºF	39.9ºF to 48.9ºF	43°F - 63°F	39°F – 49°F
Upper Lethal Limit	71.6ºF	77.0ºF	73°F	75°F

Figure 12. Temperature requirements for anadromous salmonids related to fresh water life stages.

The Oregon water quality standard that applies to the Umpqua Basin is OAR 340-041-0285, adopted as of 1/11/96, effective 7/1/96. Excerpts of the standard read as follows:

> *To accomplish the goals identified in OAR 340-041-0129(11), unless specifically allowed under a Department-approved surface water temperature management plan… no measurable surface water temperature increase resulting from anthropogenic activities is allowed:*
>
> *(i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64° F (17.8° C);*
>
> *(ii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55° F (12.8° C)*

A stream is listed as water quality limited if there is documentation that the moving (7) day average of the daily maximum exceeds the appropriate standard listed above. This represents the warmest seven-day period and is calculated by a moving average of the daily maximums. Data for Little River indicate violations usually occur in late July/early September during the time period of interest for rearing (June 1 - September 14). Although it is unlikely that violations are occurring during the time period of interest for spawning (September 15 - May 31), data is currently not available to thoroughly assess this.

Section 303(d)(1) requires that Total Maximum Daily Loads (TMDLs) "be established at a level necessary to implement the applicable water quality standard with seasonal variations." Both stream temperature and flow vary seasonally and from year to year in Little River. Water temperatures are cool during the winter months, and exceed the State standard between the summer months of June and September when stream flows are lowest and solar radiation is highest.

The USDA Forest Service (USFS) and Bureau of Land Management (BLM) have collected summertime stream temperature data throughout Little River between 1992 and 1999 (Figures 14 and 15). Since the period of record is short for all monitored sites, no trends or absolute conclusions are drawn from the data. Analysis of data collected from 1992 to 1999, reveals that 11 of the 17 monitored sites throughout the watershed frequently violated water quality standards for rearing temperature regardless of yearly variations in climate. Water temperature in mid to lower Cavitt Creek and Little River is typically in a degraded condition for much of the summer. For example, the first 11.2 miles of Little River had 7-day average daily maximum temperatures in the mid to upper 70's for the past few years. Elsewhere in the basin, temperatures are not lethal, but they are high and result in stressful conditions for salmonids and other aquatic life that require cool water. The cumulative effects of even sub-lethal stress factors may reduce recruitment to successive life stages and eventually cause populations to decline.

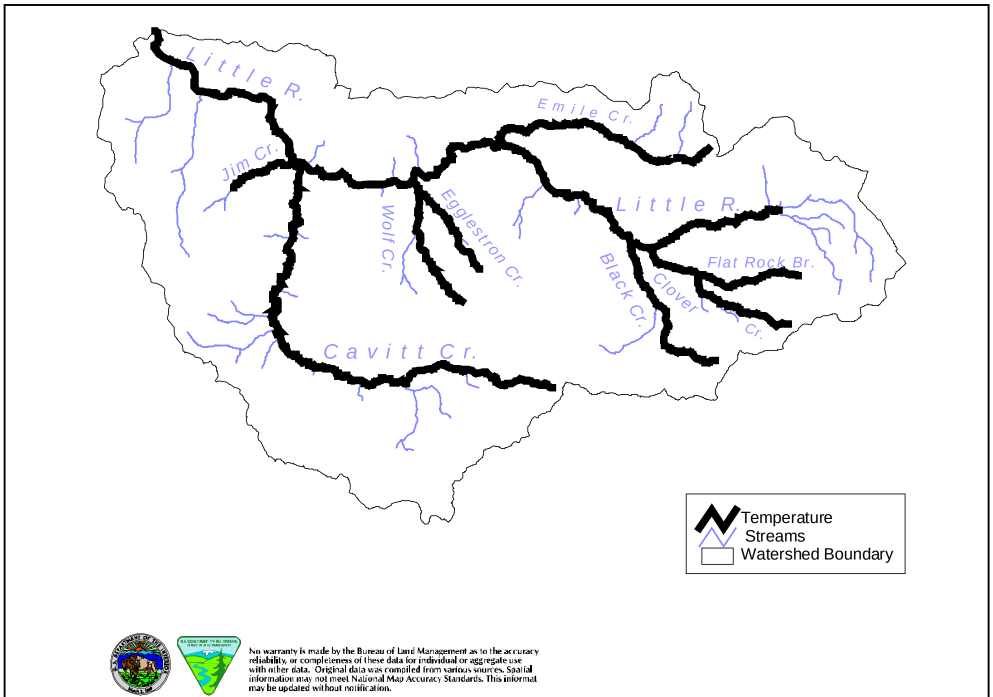

Figure 13: Little River segments currently listed for exceeding rearing temperature standards.

Based on data collected since 1994, stream temperatures in Little River and Cavitt Creek have exhibited much year-to-year variability in 7-day average daily maximums. Tributaries to Little River tend to have less variability. This is likely due to more streamside shade. The rate of stream heating that occurred in 1995 (considered a "normal" year for precipitation and temperatures) for main stem Little River from Clover Creek to White Creek was 0.5° F per mile, from White Creek to Cavitt it was 0.7° F, and from Cavitt Creek to the mouth of Little River it was 0.25° F (using 7-day average daily maximums).

Site Name	Period of Record	7-day ave. daily max. all years (F°)	Max. days over 64 (year)	Drainage area above temp. site (ac)
Cavitt Creek (mouth)	1994-1997	72.7	69 (1995)	32,157
Egglestron	1996, 98, 99	64.9	None	1,746
Emile	1996-1999	67.3	3 (1999)	1,220
Fall	1996-1999	61.2	None	5,526
Lower Jim	1994-1999	63.9	None	2,757
Upper Jim	1994, 1995	59.4	None	1,676
Little River (above Cavitt)	1994-1998	76.3	83 (1995)	76,558
Little River (mouth)	1994, 95, 97	78.1	75 (1995)	131,982
Little River (above Wolf)	1998, 99	73.8	56 (1999)	70,996
Rattlesnake	1999	63.0	1 (1999)	1,172
Wolf Creek (mouth)	1994, 1995	66.7	49 (1995)	5,774
Little River (Below Junction Cr.)	1994	61.6	None	8,859
Cultus Creek (mouth)	1995-1999	62.2	4 (1998)	5,364
Clover Creek (mouth)	1994-1999	67.7	60 (1998)	7,368
Little River (above Clover Cr.)	1995-1999	66.6	64 (1997)	14,949
Flat Rock Branch	1996-1999	64.8	45 (1998)	2,862
Little River (below White Cr.)	1994-1996, 1998, 1999	68.7	60 (1998)	37,632

Figure 14. Little River Temperature Summary. June to September only (includes stations showing data meeting standards).

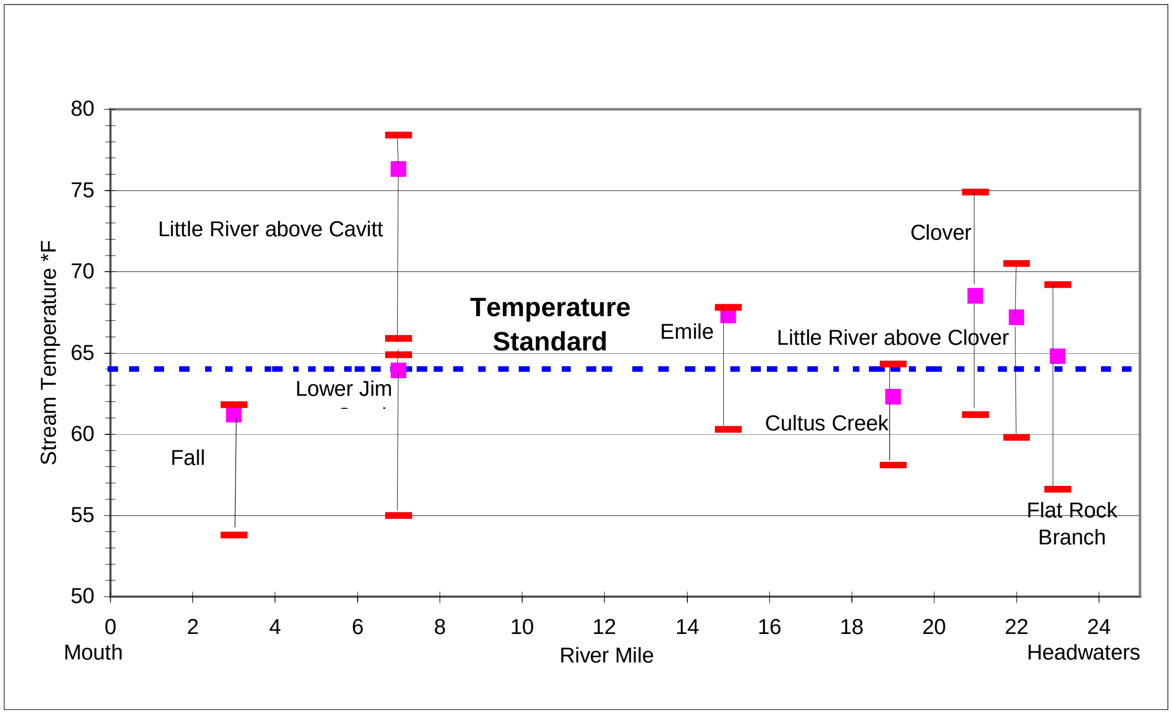

Figure 15. Graph of the moving (7) day average, as well as the range of daily maximums for temperature monitoring sites in the Little River watershed for 1996-1999. The mean is represented by the square. The range is depicted by the upper and lower bars. All displayed sites have a period of record of at least three continuous years. Cooler stream temperatures were encountered in 1995 and 1999 while 1994 temperatures were warmer.

Temperature Factor 1: Stream Shade

Stream temperature is influenced by riparian vegetation, stream morphology, hydrology, climate, and geographic location. While climate and geographic location are outside of human control, the condition of the riparian area, channel morphology and hydrology can be altered by land use activities. The elevated summertime stream temperatures measured throughout the Little River watershed result mainly from removal of riparian vegetation that compromises stream surface shading.

Stream temperature is driven by the interaction of many variables. Energy exchange may involve solar radiation, long wave radiation, evaporative heat transfer, convective heat transfer, conduction, and advection (e.g., Lee 1980, Beschta 1984). While interaction of these variables is complex, some are much more important than others (Beschta 1987). The principal source of heat energy for streams is solar energy striking the stream surface (Brown 1970). Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy (Brown 1969, Beschta et al. 1987, Holaday 1992, Li et al. 1994). Stream surface shade is dependent on riparian vegetation type and condition. The ability of riparian vegetation to shade the stream throughout the day depends on vegetation height and the vegetation position relative to the stream. For a stream with a given surface area and stream flow, any increase in the amount of heat entering a stream from solar radiation will have a proportional increase in stream temperature.

Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al. 1982, Brown 1983, Beschta et al. 1987). The condition of the riparian vegetation varies considerably in the Little River basin. The majority of the riparian vegetation is composed of narrow bands of hardwood and conifer species, where many if not all larger conifer trees have been removed. Such altered riparian areas are not sources of large woody debris and they lack the cool, moist microclimate that is characteristic of healthy riparian zones. These riparian corridors are not representative of the historical riparian condition. Based on 1946 and 1947 aerial photos of the basin, 72% to 88% of the historic riparian zones were late-seral, large conifers and hardwood stands (Little River Watershed Analysis 1995). Some spatial heterogeneity did exist in riparian vegetation due to primarily natural disturbance such as fire and blow down. Presently, only 30% of the riparian vegetation (based on NWFP ROD buffers) is considered late seral along fish-bearing streams in the basin (Little River Watershed Analysis 1995).

The shadow model (Park 1993) was used to estimate the existing shade in riparian areas for perennial (class 1,2,3) streams. Model parameters included active channel width, vegetative overhang, riparian tree height, shade density, and stream orientation. Active channel width and vegetative overhang were calculated based on stream orders and were derived from field-observations. Little River was divided into representative reaches based on stream orientation and riparian conditions. Existing shade values for perennial reaches were then calculated using the model. Target shade was determined from reference stream reaches that have riparian trees at site potential (average maximum height possible given site conditions). Years to full site potential represents the number of years to reach site potential tree height (and target shade). It may be affected by natural events.

Target shade values represent the maximum potential stream shade based on the site potential tree height. Riparian areas that reach target shade may or may not reduce stream temperatures below the Umpqua Basin stream temperature standard. Figure 16 displays the existing and target shade values for federal lands within the Little River watershed.

Riparian harvest has been a major contributor to shade reduction in the upper Little River watershed. Shade along the lower main stem has also been impacted by agriculture and human settlement. Natural processes that may elevate stream temperature include drought, fires, insect damage to riparian vegetation, diseased riparian vegetation, and blow down in riparian areas. The gain and loss of riparian vegetation by natural process will fluctuate within the range of natural variability. This WQRP focuses on human-caused disturbance that is under the control of the federal land management agencies.

Location	% Existing Shade	% Target Shade	% Shade Loss	Years to Full Site Potential
Hemlock Creek	87	91	- 4	45
Little River (above Hemlock Cr.)	87	91	- 4	35
Pinnacle Creek	80	89	- 9	75
Junction Creek	83	89	- 6	30
Little River Canyon	78	83	- 5	60
Emile Creek (below RM 4.8)	80	86	- 6	60
Emile Creek (above RM 4.8)	76	90	- 14	45
White Creek	84	90	- 6	45
Clover	87	88	- 1	15
Clover (Trib A)	85	91	- 6	35
Clover (Trib B)	86	91	- 5	35
Flat Rock Branch	90	91	- 1	10
Black Creek	80	90	- 10	50
Dutch	78	87	- 9	35
Cavitt Creek (above Withrow Cr.)	85	91	- 6	50
Cavitt Creek (below Withrow Cr.)	67	84	- 17	85
Cultus Creek	84	91	- 7	50
Plus Four Creek	84	91	- 7	40
Tuttle Creek	80	91	-11	70
Buckhorn Creek	64	88	-24	52
Fall Creek	63	90	-27	47
Rattlesnake	88	90	- 2	25
Engles	80	90	-10	30
Jim Creek	67	85[1]	-18	46
Bond	85	88	- 3	42
Greenman	71	88	-17	45
Wolf-Egglestron	77	89	-12	38

Figure 16. Current shade conditions and potential recovery for federal lands in Little River and its tributaries.

1. A large fire in 1987 affected the target shade calculations in Jim Creek.

Temperature Factor 2: Flow

The temperature change produced by a given amount of heat is inversely proportional to the volume of water heated (Brown 1983). A stream with less flow will heat up faster than a stream with more flow given all other channel and riparian characteristics are the same. Groundwater inflow tends to cool summertime stream temperatures and augment summertime flows. Reductions or elimination in groundwater inflow will have a warming effect on a stream.

The Little River watershed experiences extreme flow conditions typical of southwestern Cascade streams. Historical flows are a function of seasonal weather patterns: rain and snow in the winter months contribute to high flow volumes, while the summer dry season reduces flow, usually to 20 cfs at the Peel gauging station.

Water is withdrawn from Little River and tributaries, as well as nearby groundwater sources, primarily for domestic and irrigation uses. A total of 111 domestic water rights and 109 irrigation rights have been issued by the State of Oregon. Summer base flows in the lower reaches of Little River and Cavitt Creek are reduced by water withdrawals; however, the volume that is appropriated is very small. The Oregon Water Resources Department estimates that only 50% of consumptive rights are being utilized at any given time.

Irrigation	Agriculture	Domestic	Industrial	Municipal	Recreational	Miscellaneous	Total
9.86	0.05	1.24	0.36	0.00	0.11	0.28	11.90

Figure 17. Consumptive uses in cubic feet/second.

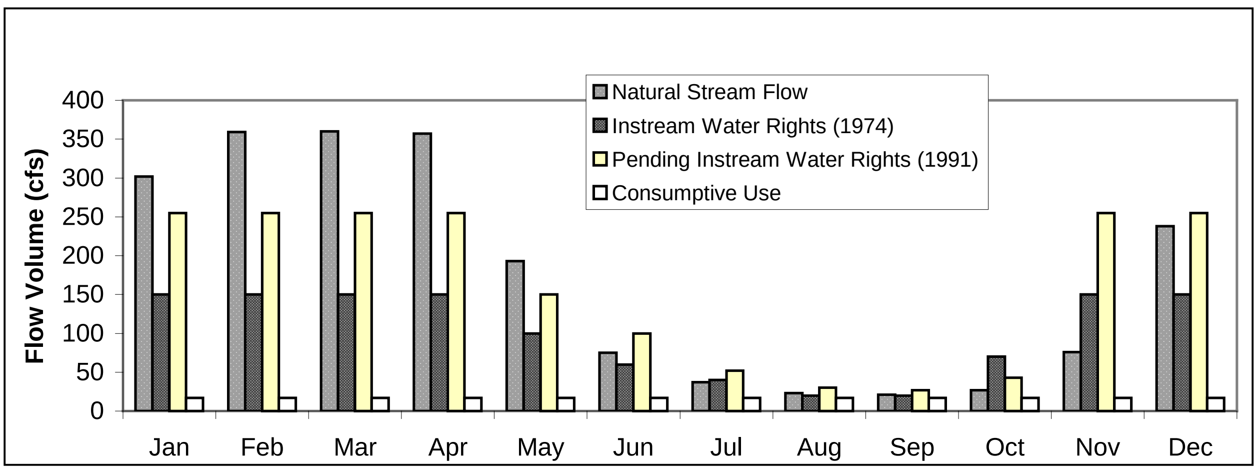

Figure 18. Natural stream flow at 80% exceedance level, in stream water rights (1974), pending in stream water rights (1991), and consumptive use occurring over one year at the mouth of Little River.

Appropriation of water is based on both water right seniority and water availability. As stream flows recede, those with junior rights are the first required to curtail use. Senior water right holders are allowed to continue using water, even in dry years and low flow conditions, as long as water is available to meet the demand under their priority date. Pending and issued in-stream water rights on Little River are based on flow requirements necessary to maintain fish habitat as determined by ODFW. The priority dates for the in-stream rights on Little River are 1974 and 1991. Because these rights are junior, the amount of consumptive use subject to regulation is very small. Even if all users were regulated off, it is unlikely the in-stream rights would be met during the dry summer months due to low total consumptive use and low seasonal stream flows.

New water rights for irrigation from Little River and tributaries are no longer being issued as natural stream flows are not sufficient to meet existing consumptive and in-stream rights during the irrigation season. Domestic rights may still be obtained if the applicant can demonstrate that surface water is the only available source for their use. The Oregon Water Resources Department (OWRD) and ODFW have identified the Little River watershed as high priority for stream flow restoration efforts under the Oregon Plan for Salmon and Watersheds (personal communication w/ Dave Williams, Water Master, Douglas County).

Temperature Factor 3: Stream Channel Morphology

While solar radiation and flow play a large role in determining stream temperature, stream channel morphology can also affect stream temperature. Streams that are narrow and have a high percentage of their streambed dominated by cobble and gravel are less prone to thermal loading than wide channels that are dominated by bedrock. Large wood plays an important role in creating stream channel morphology. Obstructions created by large wood help to settle out gravel. The deposition of gravel helps to decrease thermal loading by reducing the amount of water exposed to direct solar input, as a portion of the water will travel sub-gravel and not be exposed to sun. The removal of large wood has had a direct impact on stream channel morphology. Once the large wood was removed, the alluvial material held behind it washed out, causing channels to down-cut and eventually widen, allowing for increased thermal loading and stream heating. A more extensive discussion of stream morphology is included under the habitat modification parameter.

Management Actions

Narrow buffers (30 to 102 ft. wide), especially those providing direct shade over water, protect harvested forest streams from increases in temperature above their normal warming trends (Zwieniecki and Newton 1999). The Standards and Guidelines contained in the Northwest Forest Plan (NWFP) require riparian reserves along streams. Riparian Reserve widths are defined in the Aquatic Conservation Strategy (ACS) portion of the Standards and Guidelines. They are based on the site-potential tree height or a minimum slope distance, whichever is greatest unless described otherwise in a watershed analysis. Within these Reserves, timber harvest is prohibited except when catastrophic events result in degraded riparian conditions and salvage or fuel woodcutting would help attain ACS objectives. In addition, silvicultural practices to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics are to be applied when needed to achieve ACS objectives.

Under the NWFP, management actions which affect shade and therefore address the target loading allocation, include allowing riparian vegetation to grow to target shade values and using silvicultural practices where needed to meet ACS objectives. The watershed analysis recommends the following in Riparian Reserves:

Recommended treatment:

- Thinning in previously harvested riparian areas to enhance the growth of large conifers
- Thinning in older riparian stands that are unnaturally overstocked (due to fire suppression) to reduce the fire hazard and loss of ecological function
- Planting in under-stocked riparian areas to restore hardwood and conifer species

Focused on:

- Previously harvested, dense stands
- Unnaturally dense stands of mid- to late-seral trees along wide valley channels or steep ground that are at elevated risk of catastrophic fires and loss of ecological funtion
- Under-stocked stands that would provide the greatest benefit to streams with severe water temperature problems

C. pH

Introduction

The beneficial use affected by pH is resident fish & aquatic life and water contact recreation. The relevant Oregon water quality standard for the Umpqua Basin [OAR 340-41-0285 (2) (d)] is:

> *(A) Fresh waters (except Cascade lakes) and estuarine waters: pH values shall not fall outside the range of 6.5 to 8.5.*

A stream is listed as water quality limited if there is documentation that greater than 10 percent of the samples exceed standard and a minimum of at least two exceedences of the standard for a season of interest. The season of interest is summer, which is June 1 through September 30.

Many chemical and biological processes in a stream are affected by pH. The standard for pH values indicate the lower and upper limits that protect most aquatic species in western Oregon. Values outside of this range (within which salmonid fish species evolved) may result in toxic effects to resident fish and aquatic life (EPA 1986). When pH is outside this range, it can reduce the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. However, the effects of elevated pH on wild fish in a "natural" system have not been determined. The highest known documented juvenile steelhead trout densities on the Umpqua National Forest occur in a reach of stream with a pH as high as 8.9.

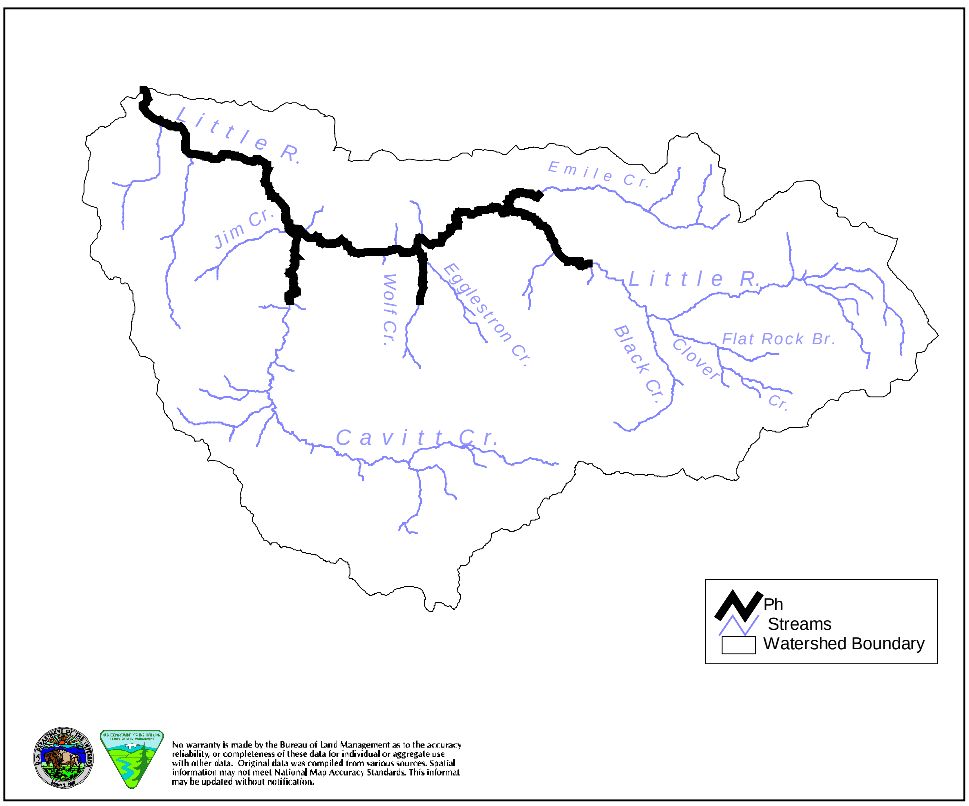

Figure 19. Little River segments currently listed for exceeding pH standard.

Existing Data

Single afternoon samples collected by US Geological Survey staff in Little River in July, 1995 found stream pH values near or above the water quality standards. Values of 8.1, 8.6, and 8.4 and 8.3 were measured near Black Creek, above Wolf Creek, and the mouth of the Little River, respectively (US Geological Survey Draft report 1996). The stream pH values recorded earlier in the day were well within water quality standards. Measurements taken for the Umpqua National Forest in August 1994, indicated afternoon pH levels exceeding numerical criteria in the lower 18 miles of the Little River main stem (Little River Watershed Analysis 1995).

Stream pH values are greatest in the afternoon, an indirect result caused by the consumption of carbon dioxide during photosynthesis (Stumm and Morgan 1981). Photosynthesis and aquatic plant growth follow yearly and diurnal cycles, which in Little River, are greatest during summer afternoons. The highest stream water pH values correspond to these periods of maximum photosynthesis. Conversely, pH values tend to be lower during the early morning hours and during the winter. Photosynthetic activity in dense algae mats can cause carbon depletion in the water column by taking up dissolved carbon dioxide faster than the atmosphere can replenish it. As carbon depletion progresses, there is an increase in pH as the equilibrium between dissolved carbon dioxide (CO_2), bicarbonate (HCO^-_3) and carbonate ions (CO_3^{-2}) moves towards carbonate.

Streams high in carbonates have a natural buffering capacity to dampen diurnal variations in pH attributable to photosynthesis and depletion of carbon dioxide. However, most western Oregon streams are low in alkalinity (carbonates) and many streams have pronounced diurnal pH swings. The US Geological Survey (1996) reported a single alkalinity value of 51 mg/l ($CaCO_3$) near the mouth of the Little River. Powell (1996) reported lower alkalinity at sites higher in the watershed (Powell and Rosso 1996). A median alkalinity value of 28 mg/l ($CaCO_3$) was reported by US Geological Survey (1996) for the North Umpqua basin.

Possible Causes of High pH

High summertime stream pH values in Little River probably result from algae growth due to the combined effects of the following:

1. Inadequate stream surface shading.
2. Increased nutrient inputs above background levels due to forest, agricultural, and residential land uses which may indirectly have an affect on pH (MacDonald et al 1991).
3. Increased channel scouring caused by increased peakflows from harvest units and roads.
4. A deficiency of large wood in the active channel.
5. Natural events and naturally occurring high pH values.

The availability of nutrients such as nitrogen and phosphorus can limit algae growth rates and photosynthesis. Inorganic nitrogen concentrations are very low in the North Umpqua River above the Little River confluence. US Geological Survey (1996) data indicate that inorganic nitrogen concentrations were undetectable (<5 ug/l) at most monitoring locations. In a single sample, collected near the mouth of Little River, ammonia and nitrate were below the levels of detection (<2 ug/l and 1 ug/l, respectively) (USGS 1996). Nitrogen is likely to be taken up by the algae immediately upon entry into the stream rather than to remain in the water column, therefore water column measurements may not accurately portray nitrogen concentrations. Total phosphorus and soluble reactive phosphorus concentrations were 7 ug/l and 1 ug/l, respectively. The US Geological Survey (1996) reported soluble reactive phosphorus concentrations were relatively plentiful elsewhere in the North Umpqua basin with median concentrations greater than 20 ug/l. Little River data and information collected elsewhere in the North Umpqua basin indicate that the availability of nitrogen highly affects the productivity of algae.

Elevated nutrient inputs from forest and agriculture land use, poorly sited or faulty septic systems, and sewage treatment system discharges promote primary production (algae growth) and elevated pH levels. Chemical fertilizers applied to commercial forest lands, agricultural areas and residential yards may be nonpoint sources of nutrients. While studies are currently underway, at this time no ambient data is available to definitively assess the affects of fertilizer application on water quality.

The Wolf Creek Conservation Center and the Christian Camp represent the only surface water point source discharges in the Little River watershed. There are several other potential sources, including failing *water pollution control facility* (WCPF) systems that do not discharge directly to surface waters.

Reduced stream surface shade has been shown to increase pH by encouraging photosynthetic chemical reactions associated with plant growth (DeNicola et al. 1992). Increased algal productivity in response to increased solar exposure has been well documented (Gregory et al. 1987, DeNicola et al. 1992).

High wintertime peak flows often scour streambeds, creating channel bottoms dominated by bedrock and/or large grained substrate, on which algae prefer to attach and grow. Bedrock stream reaches, commonly found in the Little River, provide favorable habitat and surface area for algae and poor habitat for algae eating aquatic insects. Ditches along roads that concentrate and funnel water to streams can increase peak flows.

Channel simplification may also promote algal growth and accumulations. Streamside harvest limits recruitment of large wood to the channel and floodplain. Powell (1996) suggests that poor woody debris recruitment can potentially increase pH. Large woody debris plays an important role in shaping stream channel complexity and bed form. Streams with a deficiency of large woody debris offer poor habitat for grazing macroinvertebrates that eat algae.

Natural processes that may elevate stream pH include floods, fires, insect damage to vegetation, diseased vegetation, and wind throw in riparian areas. These natural processes affect stream pH by increased nutrient loads delivered to the stream, increased solar exposure, and streambed scouring. Little River may also have naturally occurring high pH levels due to geology and the lack of connectivity between flood plain and riparian areas, which may affect the buffering capacity of riparian areas.

Management Actions

Due to the relationship of stream shade, large woody debris, and stream simplification to elevated pH values, restoration measures to address the temperature and sediment listings are also expected to improve elevated pH values. These include:

- Increased riparian vegetation growth to target shade values, which will reduce photosynthetic chemical reactions & algal productivity, and improve large wood recruitment.
- Reduction of sediment delivery to streams that will help improve channel complexity.
- Reduction of road effects on peak flows which will reduce streambed scour and alluvial erosion.
- Place large wood within tributaries and the main stem of Little River.

In addition, the watershed analysis recommends study of the effects of operational forest fertilization on pH. The Roseburg BLM has recently initiated several such studies. The first study is examining how fertilizer nutrients move through and affect the ecosystem. The second is examining the impacts to wildlife in terrestrial and aquatic riparian environments. The U.S. Geological Survey is conducting these studies.

D. Sediment

Introduction
For this parameter, the beneficial uses affected are: Resident Fish & Aquatic Life, Salmonid Fish Spawning & Rearing. The relevant Oregon water quality standard for the Umpqua Basin [OAR 340-41-0285 (2) (j)] is:

> *The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed.*

A stream is listed as water quality limited if there is documentation that habitat conditions are a significant limitation to fish or other aquatic life as indicated by the following:

> *Beneficial uses are impaired. This documentation can consist of data on aquatic community status that shows aquatic communities (primarily macroinvertibrates) which are 60 % or less of the expected reference community for both multimetric scores and multivariate scores are considered impaired…*
>
> *-or-*
>
> *Where monitoring methods determined a Biotic Condition Index, Index of Biotic Integrity, or similar metric rating of poor or a significant departure from reference conditions.*
>
> *-or-*
>
> *Fishery data on escapement, redd counts, population survey, etc. that show fish species have declined due to water quality conditions; and documentation through a watershed analysis or other published report which summarizes the data and utilizes standard protocols, criteria and benchmarks. Measurements of cobble embeddedness or percent fines are considered under sedimentation. Documentation should indicate that there are conditions that are deleterious to fish or other aquatic life.*

The cumulative sediment impacts to fish and aquatic life from management activities appear to be widespread in the watershed. Little River was listed as Water Quality Limited for sediment based on information contained in the watershed analysis. This included aquatic insect assemblages, the early emergence of sac-fry from spawning gravels, and visible evidence of large amounts of fine sediment in spawning gravels. Increased sedimentation may cause sac-fry (larval fish) to emerge prematurely from the spawning gravels. Studies have shown that sac-fry are often forced out of gravel before they have absorbed their yolk sacs. Fine sediments fill the interstitial pore spaces of the redd, resulting in a lack of intergravel dissolved oxygen (Tappel and Bjornn 1993).

Loss of pool frequency and pool area may also result from sedimentation. Although it is difficult to directly link a particular sediment source with a specific pool, studies indicate excessive sedimentation may play a role in reducing pool depth and frequency (Lisle and Hilton, 1992).

Increased winter peak flows result in intensified water velocity in channels that erodes stream banks and modifies channel morphology. Exposure to the stresses of these exacerbated peak flows likely lowers over-winter survival of juvenile salmonids.

Aquatic insects are sensitive to changes in aquatic habitat and are often used to assess the quality of habitat conditions. Aquatic insects serve as the primary food source for fish and play an important role in stream ecology. The richness and variety of macroinvertibrate species is affected by excessive sedimentation because sediment may fill the interstices between coarser substrate and reduce available habitat.

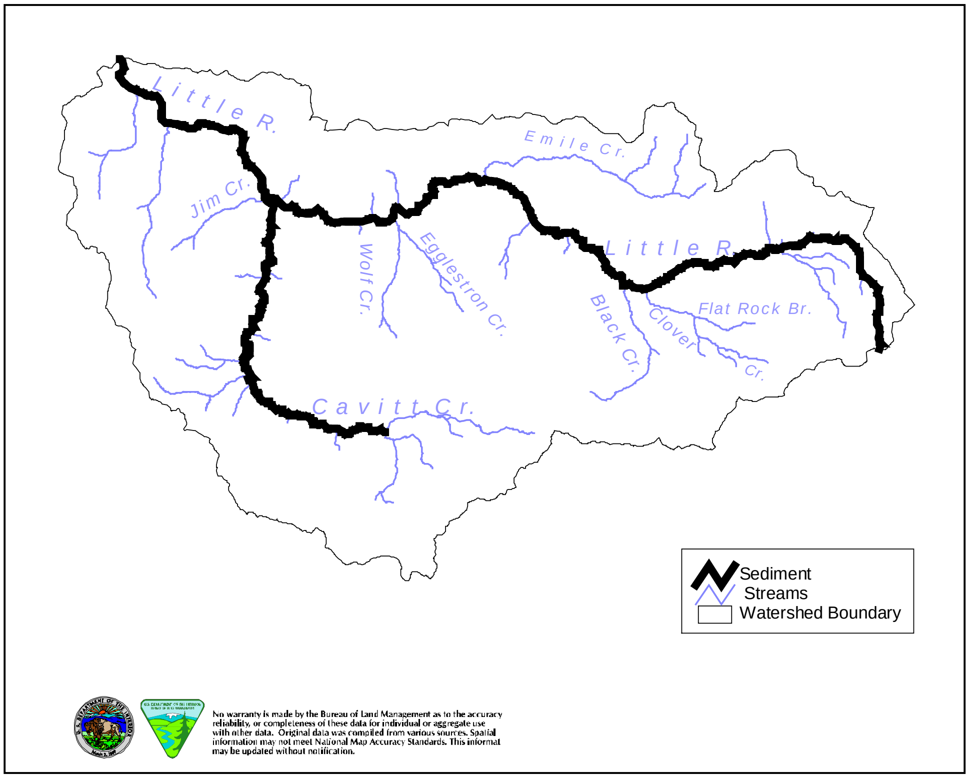

Figure 20. Little River stream segments currently listed for exceeding sediment standards.

Sediment Sources (Source Loading)

The Little River watershed lies within the North Umpqua sub-basin and drains portions of the Western Cascade Range, the Klamath Range and the Coast Range (Figure 21).

Much of the watershed lies within the Western Cascades geologic province (83%), while the Klamath and Coast Range geologic provinces account for 11% and 6% of the watershed, respectively (Little River Watershed Analysis 1995). The geomorphic processes of surface erosion, fluvial (stream-related), and landslides (mass wasting) are natural cyclic processes that strongly influence sediment production, and delivery in Little River. The mass movement of soil is a major component of hill slope erosion and sediment transport in streams in mountainous terrain. In steep areas, high precipitation events are more likely to trigger mass soil movements, which can introduce large pulses of sediment to stream channels (MacDonald et al, 1991). When landslides occur at a natural rate, they provide an important supply of gravel and large trees from upslope locations to lower order stream reaches. Landslides and bank erosion are the dominant sources of sediment in unmanaged systems (Norris, et al 1999).

Stream flows and sediment delivery are affected by the timing and intensity of rainfall delivery to streams. Sediment may be produced upslope of streams but may not be delivered until a large storm event occurs. High peak stream flows cause bank failures (mass wasting as a result of undercutting adjacent slope), entrenchment, and bed scour (Watershed Analysis 1995).

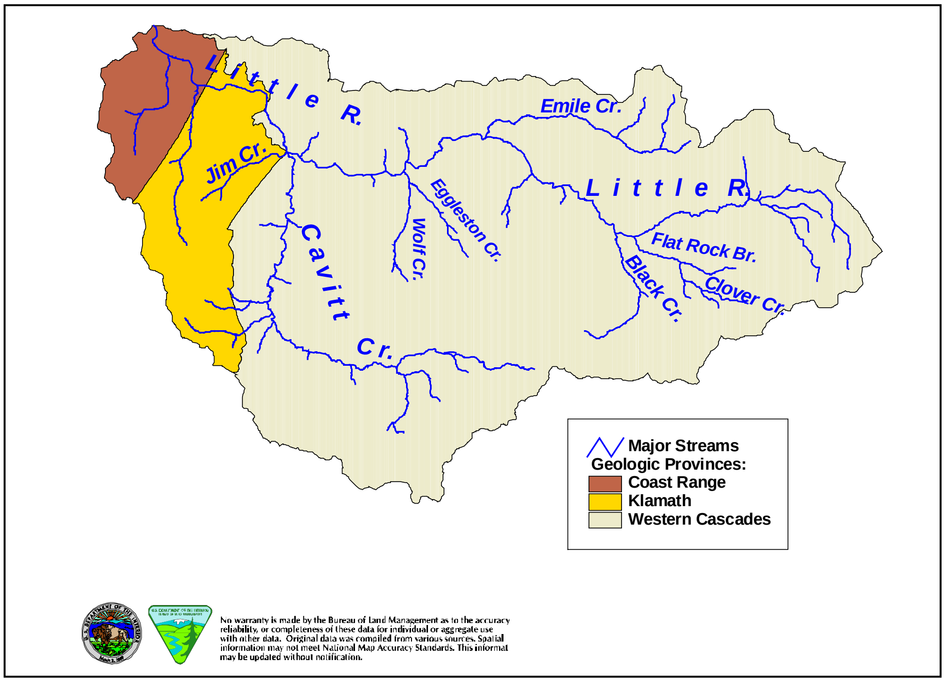

Figure 21. Geologic provinces in the Little River watershed.

Large wood in streams serves as an important storage mechanism for sediment. Over time, wood is delivered via chronic and episodic events to first- and second-order streams where it traps sediment. The buildup of wood and sediment continues until it is delivered downstream, through mass movement of the material (debris torrent) during large stream flow events. The material is then incorporated into the channel structure of larger streams where it becomes part of normal stream function (Norris et al 1999). In streams with extremely high sediment loads, the few areas of quality spawning gravels are often only found in association with these wood formations where the wood increases localized flow enough to flush clean an area of gravel (Watershed Analysis 1995).

Sediment is a natural part of stream systems and there is an equilibrium between sediment input, routing, and in-stream storage that needs to be maintained to have healthy stream systems. This means maintaining a balance between the amount of fine sediment, coarse bed load sediment and larger elements of in-stream structure (wood, boulders).

Sediment Budget

Management activities have affected this natural equilibrium by increasing sediment inputs and decreasing in-stream storage. A sediment budget provides a framework for categorizing sources of sediment and analyzing the effects of land use on sediment production and routing:

$$\text{sediment input} + \Delta \text{ in-stream sediment storage} = \text{sediment output}$$

Landslides, soil creep, and surface erosion contribute varying degrees to the overall inputs. Data from a study for the lower reach of the North Umpqua River (Stillwater Sciences 2000) provides an estimate of sediment loading. Uncertainties regarding this sediment budget result from a lack of data on the storage component, surface erosion, and deficiencies in the methodology of the landslide inventory used in the Little River watershed analysis.

Road surface erosion was estimated using SEDMODL and results indicate an average of 4.2 tons/mi²/yr. Surface erosion from harvest was estimated using GIS (page 31), but it is unlikely that much of this erosion is delivered to streams. Vegetative buffers are usually effective in filtering this erosion. Surface erosion is a relatively small portion of the total sediment budget.

A recent landslide study in the Tuttle and Engles Creek drainages was completed to address the deficiencies in the Stillwater Sciences analysis. Tuttle Creek represents a relatively unmanaged (or reference) setting and Engles Creek represents a managed setting. Although the area of analysis was significantly smaller (approximately 2 – 3 mi^2 vs. 560 mi^2), results indicate the average landslide area, volume, and mass as well as sediment delivery rates are significantly less than indicated in the Stillwater Sciences study.

Storage is the most poorly understood component of the sediment budget (Swanson et al 1982). Sediment storage and subsequent release by large wood removal may account for 20% of the increase in sedimentation rates above pre-management conditions (28.5 to 68.4 tons/mi²/yr) over a long-term period (Stillwater Sciences 2000). The Tuttle and Engles study inventoried the current distribution of large wood (LW) using the Forest Service Pacific Northwest Region protocol (2000). The associated sediment stored was an ocular estimation that place sediment volume in one of five categories. Tuttle Creek was identified as a "least disturbed" system with minimum riparian or large wood impacts from management activities. Engles Creek reflects management activities from the pre-stream cleanout and stream cleanout periods. Results of the study for Tuttle and Engles Creek are displayed in Figure 22 along with findings of Stillwater Sciences.

Storage & Sediment Parameters	Lower North Umpqua (Stillwater Sciences)	Tuttle Creek	Engles Creek
Stream order	$3^{rd} – 5^{th}$	3^{rd}	3^{rd}
Stream length (mile)	389	2.4	1.2
Average channel width (feet)	26	16	17
Number channel widths between LW sites (distance)	5 (130 ft)	3 (48 ft)	7 (119 ft)
Number of LW storage sites per mile [a]	41	110	44
Average sediment volume per active storage site [b] (ft^3)	1059	1012	338
Average sediment storage per length (ft^3/ft)	8	21	3

Figure 22. Large Wood and sediment storage for Lower North Umpqua, Tuttle, and Engles

[a] Large Wood storage sites occurring each mile: [(5280 ft/mi)/(ave. channel width)]/(number channel widths between LW sites)
[b] Not all storage sites inventoried had stored sediment; only those sites with stored sediment are included.

This study indicates that large wood storage sites occur twice as frequent in the selected "least disturbed" Tuttle Creek setting in comparison to Engles Creek. Stillwater Sciences' reference assumption described less frequent occurrence of large wood (every 130 feet). The average sediment storage forced by large wood was also found to be different for Tuttle and Engles creeks. The average volume of sediment stored per length of channel in Tuttle Creek was 7 times greater than Engles Creek and about 2.5 times greater than Stillwater Sciences' reference assumption. Although Stillwater Sciences estimated nearly similar volume of sediment per active storage site as found in Tuttle Creek,, there were less active sites identified (41 sites/mile) compared to Tuttle Creek (110 sites/mile).

Assuming that other managed lands in Little River watershed are similar to Engles Creek, the channels in these managed areas are storing only a third of the potential sediment at existing large wood sites in comparison to an less managed area, such as Tuttle Creek, and at about half the number of storage sites. In the long-term, the key to improving in-channel sediment storage is the growth of riparian trees. Where past management activities have replaced old growth riparian with younger stands, recruitment of large stable wood awaits the maturation (greater than 60 years [Grette 1985; Bilby and Wasserman 1989]). In the meantime, the legacy large wood in streams continues to decay and the associated storage of sediment declines (MacDonald 1991).

An output rate of 1339 tons/mi²/yr was calculated from stream gauge flows and turbidity measurements for Steamboat Creek from 1957-1996. Steamboat Creek is similar geomorphically to Little River although it appears to route flow more efficiently than Little River during flood events (USFS open file report 93-63 1993). This output is approximately 4 times that of the reference condition.

Figure 23 provides a summary of Stillwater Sciences sediment budget for the Lower sub-basin reach of the North Umpqua River and a sediment budget based on the landslide study in the Tuttle and Engles Creek drainages. Due to limited field verification, considerable uncertainty is associated with these figures. A rough estimate of the error range is ±50% (Stillwater Sciences 2000).

	Lower North Umpqua (Stillwater Sciences)		Engles and Tuttle Creek Landslide Study	
Sediment Budget	**Reference Condition (tons/mi.^{2}/yr)**	**Current Condition (tons/mi.^{2}/yr)**	**Reference Condition (Tuttle) (tons/mi.^{2}/yr)**	**Current Condition (Engles) (tons/mi.^{2}/yr)**
Input				
Landslides [a]	171[b]	798[b]	48[c]	430[d]
Soil Creep[e]	71	71	71[f]	71[f]
Surface Erosion	14[g]	Unknown	14 [g]	18[h]
Total Inputs	256	869	133	519
Output	285[g]	1339[i]	Unknown	Unknown
Storage Change	0[j]	(57)	0[j]	Unknown[k]

Figure 23. Sediment budgets for Lower North Umpqua and the Engles & Tuttle drainages.

[a]Landslide sediment inputs include rapid-shallow slope failures (including debris flows) that originate in colluvial hollows, as well as from slumps, and active toe zones of earth flows.
[b]This value is the average of sediment delivery rates based on landslide inventories in the Upper Steamboat basins and the Little River AMA watershed analysis (using 1946 photos).
[c]Current condition in Tuttle Creek, a reference drainage in Little River (with a small landslide dataset of recent features and assumption of 25 year frequency).
[d]Current conditions in Engles Creek (~2-3 mi²), a managed drainage in Little River, is based on a small landslide dataset and the assumption of a 3-year frequency of landslides observed. The landslide data are dominated by a debris flow feature initiated by road drainage in a recent clearcut. The frequency of the coincident events of storm flows and the harvest/road drainage features observed in Engles Creek is unknown.
[e]Sediment inputs from creep are assumed to be the same for reference and current conditions.
[f]Soil creep was not analyzed, these numbers are from the Lower North Umpqua sediment budget (Stillwater Sciences 2000).
[g]From studies conducted by Swanson et al (1982) in the H.J. Andrews Experimental Forest, Oregon (Western Cascades lithography).
[h]Road surface erosion was estimated using SEDMODL and results indicate approximately 4.2 tons/mi²/yr.
[i](McBain and Trush 1998).
[j]Based on an assumption of long term equilibrium between inputs and outputs (i.e. no long-term net aggradation of degradation).
[k]See figure 22 for comparison of sediment storage for Tuttle and Engles Creek by stream length (ft^3/ft).

The sediment budget equation inequalities these data imply (inputs plus storage changes not equal to output) probably result from a lack of understanding of the storage component and deficiencies in the methodology of the landslide inventory used in the little River watershed analysis. A particular deficiency is in the quantity of the inner gorge landslides that are overlooked by an aerial photo inventory.

The sediment budget is indicative of general patterns of geomorphic processes and provides rough estimates of changes in the magnitude of sediment process rates. This data indicates that current sediment inputs are up to four times that of the reference condition and are likely due to extensive and intensive management activities in the watershed. Landslides accounted for 36 – 66% of the overall sediment budget in the reference condition and 83 - 92% of the overall sediment budget in the current condition.

Geomorphic Land Types as a Framework for Analysis
The geology and soils of an area are major determinants of hill slope susceptibility to landslides. Geologic

parent materials are an important determinant affecting not only total sediment production but also the size of sediment particles from forested watersheds (Reiter and Beschta 1995). A land type map was created to help further assess sediment production and delivery (Figure 25). This map uses geology, geomorphology, and slope to derive land types that vary in their potential for erosion and mass wasting. The three high-risk geomorphic land types in Little River are:

1. Klamath Mountain Granitics – Residually weathered granitic rocks on steep-gradient, highly dissected hill slopes; episodic source of coarse-textured sediment flux via surface erosion and rapid-shallow landsliding.
2. Western Cascades Volcanics – Residually weathered lava flows and tuffaceous rocks on steep-gradient, highly dissected hill slopes; episodic source of coarse-textured sediment flux via rapid-shallow landsliding.
3. Landslide-Earthflow Complex (LS) – Unconsolidated mass wasting deposits forming large complexes in gentle- to moderate-gradient, weakly dissected terrain; chronic source of fine-textured sediment flux by fluvial erosion and slow, deeper landsliding.

The valley inner gorges on the steepest ground that abuts stream corridors (steep streams) represent the most sensitive (highest risk) landform for erosion within the three geomorphic land types described above. The deep, finer textured soils typical of landslide-earthflow complex are susceptible to stream down cutting and bank erosion (Watershed Analysis 1995). These areas are highly susceptible to accelerated detrimental (fine) sediment production caused by management activities.

Management-related (Controllable) Sediment

Natural sediment delivery processes occur and vary spatially and temporally depending on precipitation and land types. These processes deliver both beneficial (gravelly, coarse) and detrimental (fine, silty) sediment to streams. This WQRP focuses on controllable sources of sediment input & storage. Federal management-related actions that contribute to accelerated sediment production, delivery, and storage were analyzed to (1) provide a quantitative and/or qualitative assessment of management-related sediment production and delivery; and (2) target restoration where it will be most beneficial.

Roads

The road transportation network is an important influence on sediment production and delivery. In addition to the effects of land types, road density/use/design/location can be important in affecting the extent and magnitude of road-related sediment impacts (Reiter et al 1995). King and Tennyson (1984) observed altered hydrology when roads constituted more than 4% of the catchment area. This correlates to approximately 4 miles per square mile of area. Other studies evaluating storm response to road construction range up to 15% of the area in roads. Results are extremely variable because the effects of roads are not well defined and are difficult to detect, especially as the size of flood increases (Grant, Megahan, and Thomas 1999). Road densities in Little River watershed are relatively high and fairly evenly distributed (Figure 24). There are 954 miles of roads distributed over 206 square miles for an average density of 4.6 Mi/Mi^2. Road densities in the high-risk geomorphic land types are 5.1 in Landslide-Earthflow, 4.5 in Klamath Granitics, and 4.3 in Western Cascades Volcanics.

	Sub-watershed												
	Black Creek	Clover Creek	Cultus Creek	Emile Creek	Little River Canyon	Lower Cavitt Creek	Middle Cavitt Creek	Middle Little River	Red Butte	Upper Cavitt Creek	Upper Little River	Watson Mtn	Wolf Creek
Road Density (mi/mi^2)	4.9	3.7	4.5	4.0	4.3	4.8	5.3	4.9	4.4	5.0	4.4	4.7	4.5

Figure 24. Road densities (for all roads in the Little River watershed).

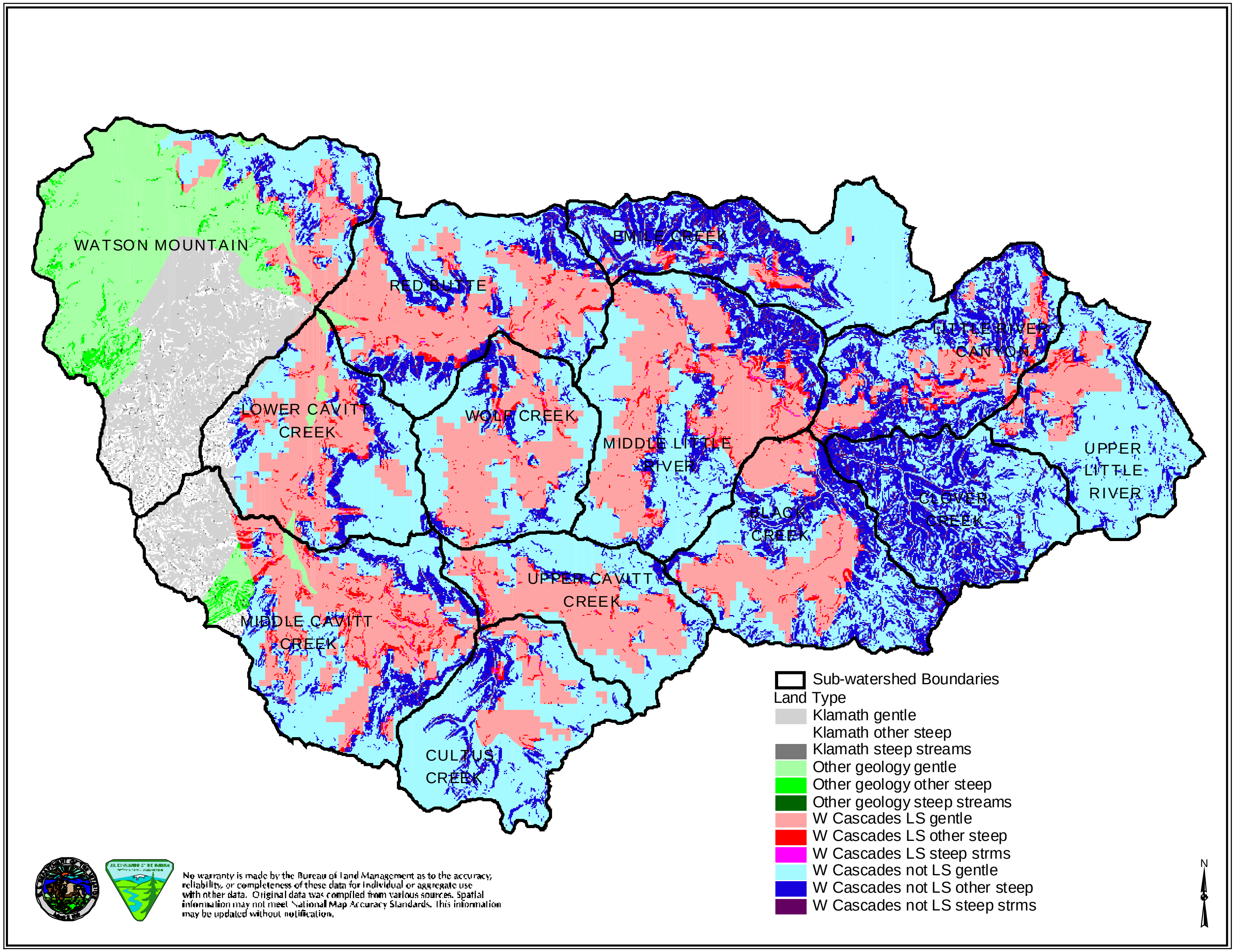

Figure 25. Land types in the Little River watershed.

Native road surfaces, road cuts & fill slopes, and ditches represent potentially exposed surfaces subject to surface erosion and mass wasting. Subsurface flow may be partially intercepted along road cuts and transferred into a more rapid runoff via ditches causing increased peak flows and mass wasting. Failed road/stream crossings and stream channel diversion pose a risk for severe sedimentation and mass wasting.

Ditches

Ditch lines along roads collect water that is drained from the road surface and cut slopes. When ditches flow into streams (effectively serving as an extension of the stream network), water is delivered more quickly than in unroaded situations thereby accelerating peak flows. Roads can act to concentrate run-off and divert natural flow patterns and potentially causing mass wasting. Data collected for a 1995 road/stream-crossing inventory of federally managed roads in Little River shows the average ditch length at stream crossings is 337 feet. Ditch length is the distance of ditch line that flows water into a stream. It is measured from the point it spills into a stream to the nearest culvert or cross drain. Figure 26 shows the number and length of ditches at stream crossings for federally managed roads in Little River. The key to reducing the effects of ditches on sediment delivery is to reduce the length of the road drainage ditch that leads directly to the point where it discharges into the channel (Norris et al 1999). Restoration would involve installing cross drains to shorten ditch lengths and disperse water away from the point it enters a stream.

Sub-watershed	Number of Ditches			
	< 300’	=> 300’ & < 600’	=> 600’ & < 900’	=> 900’
Black Creek	21	22	21	19
Clover Creek	25	11	6	3
Cultus Creek	35	19	12	1
Emile Creek	41	29	12	12
Little River Canyon	49	37	15	7
Lower Cavitt Creek	54	0	1	0
Middle Cavitt Creek	48	1	2	1
Middle Little River	45	43	16	31
Red Butte	38	19	9	5
Upper Cavitt Creek	97	0	0	0
Upper Little River	37	39	7	11
Watson Mountain	40	11	3	7
Wolf Creek	73	2	4	3
Totals	603	233	108	100

Figure 26. Number and length of road ditches for federally managed roads in Little River. The longer the ditch, the more potentially detrimental it is.

Stream Crossings

Stream crossings are the places where roads intersect streams. A drainage structure is normally installed to allow vehicle passage. In most cases, this structure consists of a culvert with soil and rock around it. Culverts can constrict the natural flow of water and restrict the normal transport of sediment and debris. When culverts become plugged and dam water, they can cause fills to become saturated, leading to failure. Plugged culverts can cause water to rise up into the road prism and spill into ditches where it is diverted to another stream. The road/stream-crossing inventory for federally managed roads in Little River was re-evaluated for this analysis to determine (1) water diversion potential and (2) the risk and consequence of road/stream crossing failure (Figure 27). Road/stream crossings were rated from 1 (low) to 5 (high) based on the risk of failure and the consequence (sediment delivery) of the failure. Bridges and other sites (such as low water fords) that had missing data germane to the assessment were not given a rating.

Restoration of stream crossings would eliminate water diversion potential and reduce the risk of failure. It includes redesigning, installing, or maintaining drainage structures and stabilizing road fills around drainage structure. All culverts should be sized to pass a 100-year flood and associated sediment and debris. Some of the information collected for the 1995 inventory was based on a subjective evaluation of conditions. A thorough site analysis will be needed during project level planning to verify the need for restoration.

Sub-watershed	Risk and Consequence of Failure (Number of Crossings by Risk Class)					Water Diversion Potential (Number of Crossings)	
	1	2	3	4	5	Yes	No
Black Creek	2	5	44	12	9	45	38
Clover Creek	8	7	15	5	3	20	25
Cultus Creek	8	17	24	9	4	28	39
Emile Creek	14	25	38	5	2	50	44
Little River Canyon	11	14	55	19	8	81	29
Lower Cavitt Creek	1	3	40	5	3	35	20
Middle Cavitt Creek	5	7	23	8	5	34	18
Middle Little River	7	21	57	34	8	78	58
Red Butte	10	15	35	8	1	48	23
Upper Cavitt Creek	8	21	43	13	6	61	37
Upper Little River	6	16	33	20	8	41	53
Watson Mountain	7	10	24	5	4	39	22
Wolf Creek	4	12	46	13	7	53	29
Totals	*91*	*173*	*477*	*156*	*68*	*613*	*435*

Figure 27. Road/stream crossings risk and consequence of failure and water diversion potential for federally managed roads in the Little River watershed. Those rated 5 have the highest risk of failure and the highest consequence of failure (only stream crossings with a culvert were given a rating). As an example, Black Creek has 2 crossings rated as a 1, 5 crossings rated as a 2, and so forth. A total of 68 crossings were rated as a 5. Water diversion potential is the likelihood high water will be diverted down a ditch into another stream.

Road Prism

Roads have the greatest potential for hydrologic effects where they parallel streams, particularly where road fills have been placed in the flood plain (BLM 2000). In valley bottoms, roads can affect stream morphology by hardening stream banks and constricting streams during high flows. On hill slopes, road fills and cut slopes that become saturated with water can fail and deliver sediment to streams. Surface erosion from inadequate (native) surfaces, rutting, and lack of cross drains is more likely to be delivered to streams when a road is close to a stream and there is little vegetative buffer. Analysis of sediment delivery due to surface erosion from federally managed roads was accomplished using SEDMODL. The model considers roads that are within 200 feet of a stream and generally identifies more delivering road segments than actually exist on the ground. The model uses elevation, road data[2], road cut slope condition, stream location, precipitation, geology, and soils information. Figure 28 shows the estimated surface erosion delivery in each sub-watershed along with the miles of road segments rated as medium or high sediment deliverers in landslide-earthflow complex. Those segments rated as medium or high deliverers that fall within landslide-earthflow complex areas are most likely to accelerate detrimental (fine) sediment delivery to streams. The watershed analysis found that the Cavitt Creek and Wolf Creek/Middle Little River areas are the areas of highest priority for transportation assessment and planning efforts.

According to Luce and Black (1999) road-related surface erosion appears to be concentrated in the first few years after construction. Landslide-related erosion could occur many years later, and is highly episodic. Wemple et al (1999) found that fill slope slides were the dominant process of sediment production from roads. An analysis of several miles of road in the Watson Mountain sub-watershed showed sediment production from road cut and fill slope mass wasting was 12 –16 times that of surface erosion. The watershed analysis found that in general, roads located on slopes in excess of 60% slope and within 200 feet of streams have the greatest

[2] SEDMODL is designed to run with road locations only or with the additional attribute information of surface/use/width. Runs of the model with attribute information on actual road conditions provide more reliable model results and can be used to examine the relative relationships between different values of sediment delivery or as a good indicator of actual sediment inputs. This information is available for federally managed roads in the Little River watershed and was used in the model. Stream location data that was used is the best that is currently available, however, there may be more ephemeral streams on the ground than are represented in GIS.

potential to deliver landslide-generated sediment to streams. All roads should have surface and drainage facilities or structures that are appropriate to their patterns and intensity of use. A study of roads in western Oregon found that variability in sediment production from road segment to road segment is high. Most segments produce little sediment, while only a few produce a great deal. It is possible to substantially reduce road erosion by targeting those sections with the greatest sediment production (Luce and Black 1999). Restoration efforts would include road treatments (installing drain dips, adding road surfacing material, repairing ruts, stabilizing road cuts and fills on slopes >60%) and road decommissioning. The SEDMODL provides an indication of relative road surface erosion and likely problem areas that will require a more detailed review to verify the need for restoration. Future roads should not be located in steep inner gorge or unstable headwall areas except where alternatives are unavailable (Redwood Creek TMDL 1998).

Sub-watershed	Total Erosion (tons/year)	Average Erosion Rate (tons/mi^2/year)	Miles of Medium/High Sediment Delivering Segments in Landslide Complex Areas
Black Creek	51	3.4	6.4
Clover Creek	23	2.0	0.0
Cultus Creek	51	4.2	1.7
Emile Creek	23	1.7	0.4
Little River Canyon	82	6.8	3.8
Lower Cavitt Creek	83	5.9	4.6
Middle Cavitt Creek	69	3.1	2.7
Middle Little River	43	2.1	4.2
Red Butte	93	5.5	3.7
Upper Cavitt Creek	86	8.1	5.2
Upper Little River	54	4.6	1.9
Watson Mountain	100	2.9	0.7
Wolf Creek	53	4.5	4.2
Totals	*811*	*4.2*	*39.5*

Figure 28. Estimated surface sediment delivery from federally managed roads in the Little River watershed. Model uses road attributes showing a breakdown of road surface and use. If model is run without this attribute information (instead using the defaults of gravel surface and light use), the total amount of sediment is 346 tons.

Timber Harvest

Timber harvest that exposes mineral soil can accelerate mass wasting (land slides) and surface erosion. Lack of forest canopy can increase rain-on-snow event peak flows leading to increased fluvial erosion. Harvest also affects (particularly when harvest occurs in riparian areas) the amount and size of woody debris that reaches streams. Woody debris increases stream habitat complexity and serves as a storage mechanism for sediment. Beneficial sediment (gravel and cobble) serves as fish spawning habitat.

Peak Flows and Bank Erosion

The large channel-forming runoff events in the Little River Watershed occur during the winter during rain-on-snow events. A common conclusion of the research on this type of runoff event has been that statistically significant peak flow increases are associated with canopy removal and roads in smaller drainages (Jones and Grant, 1996; Thomas and Megahan, 1998; Jones, 2000). The loss of canopy influences snow accumulation and melt rates. Hydrologic recovery of the canopy occurs as vegetation is re-established and may require up to 40 years (Harr and Coffin 1992) for full recovery. Hydrologic recovery has been described as including a canopy closure of 70% with an average tree diameter of 8 inches (Christner, 1982). In the absence of a recovered canopy, water input to soils is greater from increased snow accumulation and melt rate. Higher amounts of water input for the same climatic event shifts the frequency of occurrence of water input to a shorter recurrence interval. This can influence stream flows and bank erosion (Harr 1981, Harr and Coffin 1992).

As less total Federal acreage is managed in the future under the Northwest Forest Plan, hydrologic conditions in forest stands will improve in the upper areas of the watershed where Federal ownership is blocked-up and mostly contiguous. The influence of canopy on rain-on-snow events will generally diminish over time. Elsewhere in the watershed where federal lands do not occupy most of a natural drainage, the trend is not known.

A qualitative peak flow approach was adapted from the Augusta Creek Study on the Willamette National Forest (Cissel et al, 1998) to address potential bank erosion. The potential susceptibility to rain-on-snow peak flows was evaluated across the watershed by assessing likely snow accumulation and melt along with the storage of ground water. Snow accumulation is a function of elevation and is grouped into elevation zones. Snowmelt is grouped by aspect with the highest melt rates for south- and west-facing slopes. Soil depth was used to assess ground water storage and was interpreted from soil inventory data. Elevation zones, aspects, and soil depths were merged into a single GIS map to identify areas of High/Moderate/Low susceptibility to peak flows from rain-on-snow events. Figure 29 shows this potential condition for Little River Watershed.

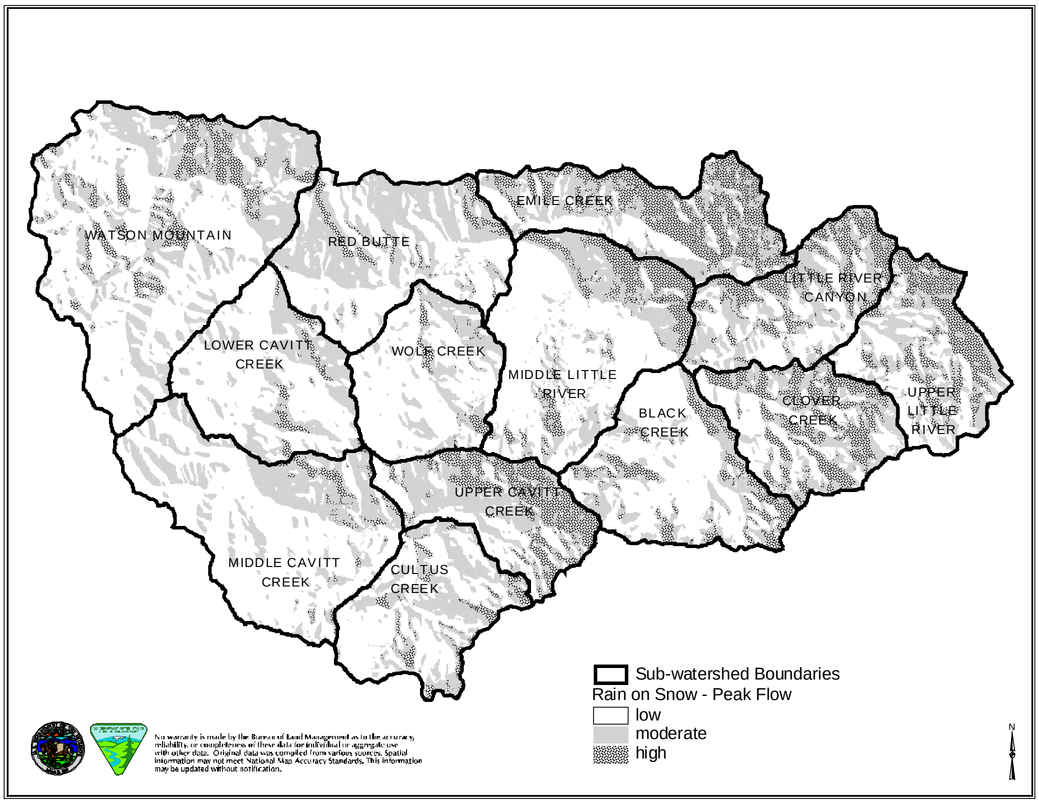

Figure 29. Potential susceptibility to rain-on-snow peak flows events in Little River.

The higher risk runoff areas in the Little River Watershed were then combined with GIS information showing forest stands that are not hydrologically recovered (stands less than 40 years old). The results identified those areas that have a higher risk of naturally augmented rain-on-snow runoff and that are likely hydrologically unrecovered. The deep, finer textured soils of the landslide-earthflow complex are highly susceptible to stream down cutting and bank erosion. Areas of high susceptibility to rain-on-snow peak flows and low hydrologic recovery that are upslope and contribute to streams in landslide-earthflow terrain would potentially have the greatest influence on bank erosion. Figure 30 provides an indication of places where additional harvest and associated roads would have the most impact on bank erosion. This graphic represents current conditions only. As both management and recovery occur, this information will change.

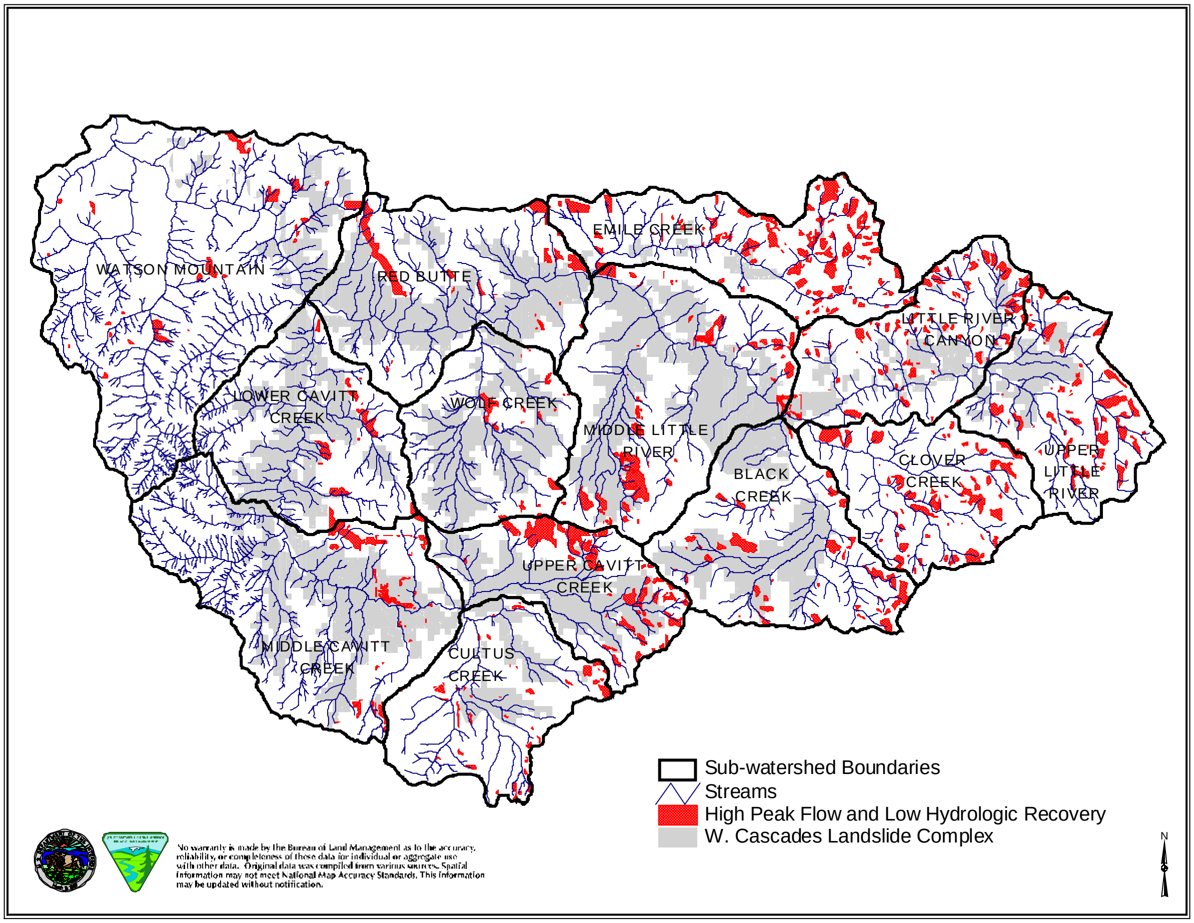

Figure 30. Bank erosion susceptibility in Little River. Additional harvest would likely have the most impact on bank erosion in areas with high susceptibility to rain-on-snow peak flows and low hydrologic recovery that flow into landslide complex terrain.

Surface Erosion

Timber removal due to harvest can cause surface erosion and sediment delivery to streams. Accelerated sediment production and delivery occurs when bare soil is exposed to heavy rainfall and the runoff reaches streams. Ground-based harvest methods can compact soils. This reduces the soil's ability to absorb water (Watershed Analysis 1995) and can lead to more overland flow of water. Generally, the accelerated surface erosion dissipates when vegetative cover is established. Only slight suspended sediment increases (excluding landslides) were found for two years following clearcut harvest in a western Oregon Cascades watershed (Reiter and Beschta 1985). Studies have shown that non-channelized (surface) transport of sediment decreases as slope decreases and the number of obstructions increases within a filter strip. Vegetation buffer strips on the order of 200 feet are generally effective in controlling sediment that is not channelized (Belt, et al 1992, FEMAT 1993). The Northwest Forest Plan provides valuable riparian vegetative filters for capturing and holding sediment from hill slope surface erosion.

Mass Wasting

Landslides can be triggered by timber harvest due to a loss of tree root strength and increased soil saturation from reduced tree canopy. Studies in Oregon and Washington generally indicate that the harvesting of trees increases the rate of mass failures by 2 to 4 times over that experienced on uncut areas (Reiter and Beschta

1995, Norris et al 1999). A landslide study by the Oregon Department of Forestry (ODF) in the Coast Range following the major storms of 1995-1996 found that the general pattern is that the rate of land sliding was highest in stands 0-9 years post harvest, and lowest in stands 10 to 100 years. They further determined that landform and slope steepness are tied to landslides rates. They found that 100% of landslides occurred on slopes > 40%, 92% of landslides occurred on slopes over 60%, and concave slopes had the greatest incidence of landslides. One-third to one-half of all landslides in the Oregon Coast Range originated in headwall areas (ODF 1998). The SINMAP model (Pack, Tarboton, and Goodwin 1998) was used to create a slope stability index map. The model uses slope and a topographic wetness index to predict slope stability. The model showed that generally, the most unstable areas are steep inner gorges (over 45% slope) and headwalls.

The watershed analysis and a study by Stillwater Sciences (2000) in the lower portion of the North Umpqua River indicates that the number of landslides has dramatically increased with the advent of management activities in the Little River watershed. Future clearcut and/or ground-based harvest should be avoided in steep inner gorge, unstable, or streamside areas unless a detailed assessment is performed which shows there is no potential for increased sediment delivery to streams as a result.

Large Woody Debris

Large woody debris is an important mechanism for the storage and slow release of sediment over time. This includes the beneficial gravel and cobble for spawning and aquatic insect production. Trees that fall into streams usually come from within 30 meters (98 ft.) of the channel edge; 70 to 90 percent of the large wood in streams is derived from this distance (Norris et al 1999). The total amount of wood in the streams may not change with timber harvest, but the size of the wood is reduced (Norris et al 1999). Today, roughly 30 percent of riparian stands along fish-bearing streams in the watershed are considered to have late seral characteristics (Watershed Analysis 1995). Figure 31 shows percent of total riparian area (using NWFP riparian reserve widths) that has been harvested since 1946.

Protection of streamside zones by leaving vegetation intact will help maintain the integrity of channels and preserve important terrestrial-aquatic interactions (Hicks et al 1991). The NWFP Standards and Guidelines provide for riparian reserves along streams. These reserves will provide a future source of large woody debris for streams. In addition, re-introducing fire into the ecosystem could provide a source of wood for streams.

	Sub-watershed												
	Black Creek	Clover Creek	Cultus Creek	Emile Creek	Little River Canyon	Lower Cavitt Creek	Middle Cavitt Creek	Middle Little River	Red Butte	Upper Cavitt Creek	Upper Little River	Watson Mtn	Wolf Creek
% Harvest in Rip. Areas	42	22	26	43	32	69	88	62	57	42	28	52	66

Figure 31. Percent of total riparian area that has been harvested (since 1946). Prior to 1946, less than 2 % of the watershed had been roaded and harvested (Watershed Analysis, 1995). Riparian areas were calculated by applying NWFP riparian reserve widths to all lands.

Summary of Management-Related Sediment Sources

Roads, landslides, and bank erosion are believed to be the dominant sources of sediment in managed systems and there is a strong interaction with storms. Canopy indirectly affects fluvial erosion through increased peak flows. Given riparian protection, landslides and roads become the dominant sediment sources likely to be influenced by management action (Norris et al 1999). In the Western Cascades, road fill failures were found to represent the most frequent cause of debris flow initiation (Swanson and Fredricksen 1982). In a study of landslides after a large storm event in the Cascade Range of Oregon, Wemple et al (1999) found that road-related erosion processes were a significant part of overall sediment production in the basin during large storm events. An Oregon Department of Forestry (ODF) study of landslides and storm impacts for the storms of 1996 concluded that while the number of road-related landslides were low, the size of these landslides were about 4 times larger on average than landslides not associated with roads. The ODF study as well as the landslide study in the Tuttle Creek and Engles Creek 7th field catchments show that landslides that enter stream channels are most common in steep, inner gorge areas adjacent to streams.

How these increased sediment inputs affect long-term in-stream sediment storage and transport is not clearly understood. Historically, it is likely that individual drainages were periodically highly impacted by sedimentation (due to episodic events such as landslides). Currently, most drainages are highly impacted.

Controllable Inputs

An overall average of 70% was used for estimating sediment reduction from management related activities. This is based on results from literature and other completed and approved TMDLs. Analysis for two completed sediment TMDLs in California show that sediment delivery for landslides due to management activity is 60% controllable (U.S. Environmental Protection Agency, Region 9, Redwood Creek TMDL 1998) and 80% controllable (U.S. Environmental Protection Agency, Region 9, Garcia River Sediment TMDL 1998). The recently approved Simpson Northwest Timberlands TMDL in Washington State based estimates of controllable sediment input on these two California TMDLs. Sediment delivery for road surface erosion has been estimated as 70% controllable (Burroughs 1989). Target sediment loading (Figure 32) is expressed as tons/mi^2/year. The target sediment loading is based on the Stillwater Sciences study data on the lower reach of the North Umpqua River (Stillwater Sciences 2000). The sediment budget for the Tuttle and Engles drainages in Little River was not used due to the small size of the analysis area.

Sediment Budget	Reference Condition (tons/mi.^{2}/yr)	Current Condition [a] (tons/mi.^{2}/yr)	Management Related (Current - Reference) (tons/mi.^{2}/yr)	Controllable Inputs [b] (tons/mi.^{2}/yr)	Target Condition [c] (tons/mi.^{2}/yr)
Input					
Landslides[d]	171[e]	798[e]	627		
Soil Creep	71	71	0		
Surface Erosion	14[f]	18[g]	4		
Total Inputs	256	887	631	442	445
Output	285[f]	1339[h]			
Storage Change	0[i]	(57)			

Figure 32. Target sediment loading for the Little River watershed.

[a]Current condition = management related + reference.
[b]Controllabe inputs = .70 x management related.
[c]Target condition = (management related + reference) - controllable load. An error range is estimated at ±50% for all figures (Stillwater Sciences, 2000).
[d]Landslide sediment inputs include rapid-shallow slope failures (including debris flows) that originate in colluvial hollows, as well as from slumps, and active toe zones of earth flows.
[e]This value is the average of sediment delivery rates based on landslide inventories in the Upper Steamboat basins and the Little River AMA watershed analysis (using 1946 photos).
[f]From studies conducted by Swanson et al (1982) in the H.J. Andrews Experimental Forest, Oregon (Western Cascades lithography).
[g]Road surface erosion was estimated using SEDMODL and results indicate approximately 4.2 tons/mi^2/yr.
[h](McBain and Trush 1998).
[i]Based on an assumption of long term equilibrium between inputs and outputs (i.e. no long-term net aggradation of degradation).

Restoration Actions and Milestones

It is difficult to quantify direct linkages among processes and functions outside the stream channel to in-channel conditions (FEMAT 1993). Due to natural sedimentation, high spatial and temporal variability in weather patterns and mass wasting, and difficulty in measuring sediment delivery/storage/transport in a stream over time it would be nearly impossible to definitively describe how much sediment a stream can accept and still meet water quality standards. It is also difficult to differentiate and measure the difference between natural and management-related sediment delivery at any specific point or time in the Little River watershed. We have attempted to characterize sediment sources, assess controllable inputs (i.e. management effects), and develop restoration actions and milestones to address these controllable inputs. When possible, conservative assumptions were used in the analysis to err on the side of the aquatic resource. This likely resulted in an overestimation of the amount of sediment production and delivery due to management activities. These include:

> -The model (SEDMODL) used for calculating surface erosion from roads overestimates the number of sediment-delivering segments. While it assumes all roads within 200 feet of a stream deliver sediment, this is generally not the case.
> -When analyzing rain-on-snow peak flows and potential bank erosion, a conservative assumption was used in estimating hydrologic recovery. It was assumed that forests <40 years of age had no hydrological recovery. In fact, hydrologic recovery of the canopy begins as soon as vegetation is re-established and continues until full recovery is achieved in 30-40 years.

Water quality indicators and restoration activity accomplishments will be used to track and monitor progress (see Chapter VI).

Milestones and priorities for restoration activity are based on addressing the highest existing and at-risk management-related contributors to detrimental sediment delivery and increased peak flows in areas where they will have the most positive effect for the beneficial use (fish). Restoration activities will substantially reduce federal management-related sediment delivery and hydrologic effects and move the sediment budget towards the natural condition on federal lands. Figure 33 provides a summary of actions and milestones.

Parameter	Management Actions (Desired Conditions)	Milestones
Use of clearcut and/or ground-based timber harvest Peak flows	Future harvesting avoids steep inner gorge, unstable, or streamside areas unless a detailed assessment is performed which shows there is no potential for increased sediment delivery to streams as a result. [1] Consider peak flows and hydrologic recovery when planning timber harvest to maintain appropriate canopy closure.	Ongoing
Road location in riparian, inner gorge, or unstable headwall areas	Future roads are not located in riparian, steep inner gorge or unstable headwall areas except where alternatives are unavailable.[2]	Ongoing
Road fill, cutslope, surface, and drainage	Roads have surface and drainage facilities or structures that are appropriate to their patterns and intensity of use. Unstable landings and road fills[3] that could potentially deliver sediment to a stream are pulled back and stabilized.	Review roads (with medium/high sediment delivery in landslide-earthflow areas) to verify the need for restoration and treat or decommission as needed. Treat or decommission other roads as indicated in project level planning efforts.
Road/stream crossings diversion potential, culvert size, and ditch length	Culverts are sized to pass 100-year flood and associated sediment and debris. Install cross drains to reduce ditch length at stream crossings. No crossings have diversion potential.	Review highest risk stream crossings to verify the need for restoration and treat as needed. Treat other stream crossings as indicated in project level planning efforts.
Large woody debris (LWD)	LWD in streams mimics natural conditions. Reintroduce fire into ecosystem.	Place LWD & reintroduce fire based on assessment of local conditions

Figure 33. Sediment-related restoration actions and milestones for Federal land in the Little River watershed.

[1] Characteristics of steep inner gorge, unstable, or streamside areas generally include the following (Redwood Creek TMDL, 1998):
-slopes > 50%
-located within 300 feet of a class 1, 2, or 3 stream
-erosive or incompetent soil type or underlying geology
-concave slope shape
-convergent groundwater present and/or evidence of past movement is present

[2] Steep inner gorge areas generally exceed 65% in slope and are located adjacent to class 1 or 2 streams. Characteristics of steep unstable headwall areas generally include the following (Redwood Creek TMDL, 1998):
-slopes > 50%
-erosive or incompetent soil type or underlying geology
-concave slope shape
-convergent groundwater present and/or evidence of past movement is present

[3] According to the watershed analysis, unstable landings and road fills are generally those that are located on slopes >60%.

E. Habitat Modification

Introduction
The beneficial uses affected by habitat modification include resident fish & aquatic life and salmonid fish spawning & rearing. The relevant Oregon water quality standards are:

OAR 340-41-027 (Biological Criteria):

> *Waters of the State shall be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.*

And specifically for the Umpqua Basin [OAR 340-41-0285 (2) (i)]:

> *The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life, or affect the potability of drinking water, or the palatability of fish or shellfish shall not be allowed.*

A stream is listed as water quality limited if there is documentation that habitat conditions are a significant limitation to fish or other aquatic life.

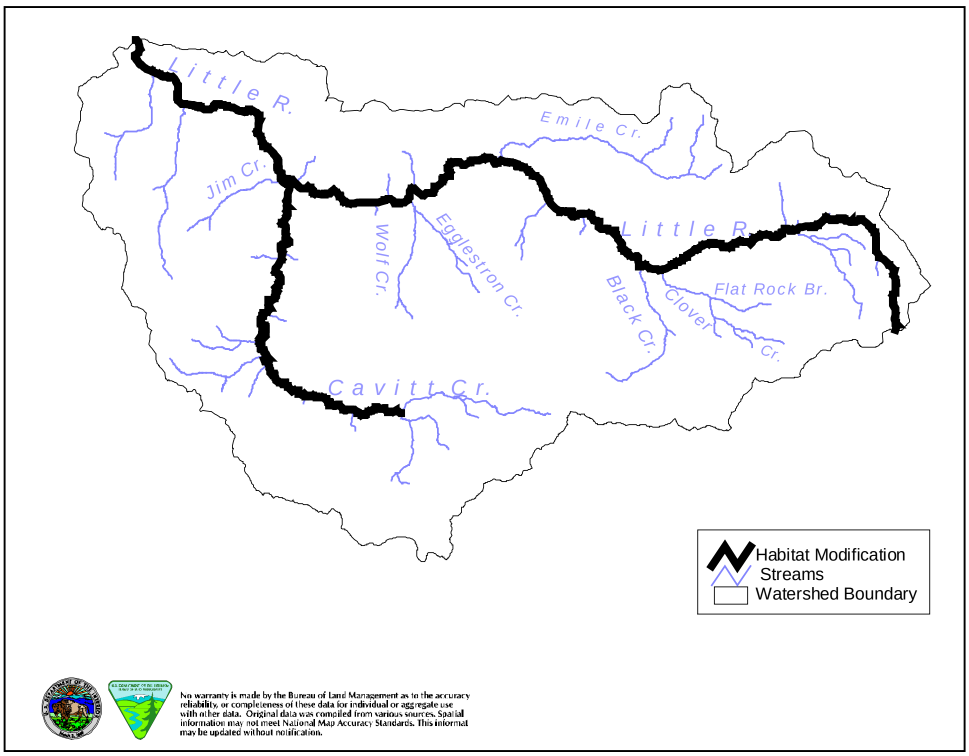

Figure 34. Little River stream segments currently listed for exceeding the habitat modification standard.

Habitat structure is an important, but often overlooked component of stream condition. Changes in riparian vegetation, floodplain interaction, substrate, and channel sinuosity influence the aquatic community of a stream. Protection and restoration of the physical and chemical characteristics of the Little River and its tributaries is necessary to maintain and restore healthy aquatic ecosystems. Alterations to these water body attributes are considered an important factor in the decline of salmonid populations in Oregon. Water bodies with relatively good water quality have been shown to be biologically impoverished when habitat quality is poor.

The combination of large-scale in-stream wood removal in the 1960's and 1970's, extensive timber harvest along streams over the last 40 years, and the exclusion of fire from the ecosystem over the last 70 years, have negatively affected stream habitats essentially throughout the basin. Stream cleanout occurred throughout the fish bearing waters of the watershed, including most tributaries where substantial timber harvest and roading took place. Naturally occurring processes that may affect aquatic habitat include floods, fires, insect damage to vegetation, diseased vegetation, landslides, earth flows, mass wasting, and debris flows. These affects may be beneficial or adverse depending upon current watershed condition.

Historic information about fish habitat quantity and quality is sparse for the Little River system; most information was only recently collected (Little River Watershed Analysis 1995). Recent stream surveys and interpretation of historical and recent aerial photographs indicate that Little River watershed has been altered in the last 100 years. In the last 20 to 30 years the recognition of the importance of habitat to salmonids has altered many management activities that were detrimental to water quality and fish. ODF&W and USFS aquatic surveys are important historical information, and include data on large woody debris, channel complexity, stream substrate, and width/depth ratio.

Surveys conducted in 1993 by the Oregon Department of Fish and Wildlife (ODFW) in the lower half of the Little River watershed provide information regarding in-stream habitat. This data was analyzed to derive a relative indication of the quantity and quality of aquatic habitat by stream reach (Figure 35). The raw data under each habitat category can be compared to the categories at the top to determine whether or not the category is in excellent, good, fair or poor condition. The summary scores (at the right of the Figure) for each stream are a result of the raw data collected and are listed by stream name. The scores are an average of all stream reaches by name and reflect the quantity and quality of aquatic habitat at the time of survey. The relative overall condition of streams can be determined by comparing the scores with the habitat benchmark rating system, which is a range of scores for excellent, good, fair and poor. Flooding and other natural or anthropogenic disturbances subsequent to stream surveys may have altered the scores and more surveys are necessary to assess any changes in aquatic health. The raw data appear to vary considerably by category and stream reach, with the exception of stream shade and large woody debris. Shade values are mostly in the excellent range, whereas numbers and volume of in-stream large woody are in a poor category. An extensive discussion of habitat conditions within the main stem of Little River and its tributaries can be found within the Little River watershed analysis and its Appendix F.

Stream	Reach	% Pool Area	Residual Pool	Width/Depth ratio	% fines in riffles	% gravel in riffles	Large woody debris	Volume of wood	Average Score*
Excellent		≥45	≥0.6	≤10	≤1	≥80	≥30	≥40	82-100
Good		31-44	0.41-0.6	11-20	2-7	71-79	20-29	30-39	63-81
Fair		16-30	0.21-0.4	21-29	8-14	61-70	11-19	21-29	44-62
Poor		≤15	≤0.2	≥30	≥15	≤60	≤10	≤20	25-43
Bond Creek	1	10.7	0.4	25.5	44	31	5.1	8.3	
	2	13.6	0.3	7.8	47	41	12.7	31.2	50
Boulder Creek	1	32.2	0.2	21.8	42	26	7.8	10.3	
	2	30.9	0.3	16.3	54	22	15.2	36.8	
	3	47.1	0.3	7.1	46	31	7.2	25	
	4	1.6	0.5	10.7	71	28	8.6	20.7	
	5	0	0	--	26	16	8.6	28.6	46
Buckhorn Creek	1	33.6	0.5	27.8	40	54	1.6	0.8	
	2	20.8	.6	33.3	34	30	3.0	3.6	
	3	17.2	0.5	29.3	37.0	33.0	1.3	1.1	47
Buckshot	1	8.4	0.6	---	9.0	11.0	8.7	14.5	42
Cavitt Creek	1	67.6	0.9	49.5	6.0	13.0	0.3	0.1	
	2	48.4	1.4	45.2	8.0	17.0	0.4	0.2	
	3	46.0	0.9	37.9	8.0	12.0	0.2	0.2	
	4	56.8	1.0	29.5	0	15.0	2.7	3.0	
	5	53.2	0.9	75.8	6.0	92.0	5.3	4.5	
	6	75.4	1.0	64.0	7.0	68	7.6	5.3	
	7	35.8	0.8	67.2	1.0	41	1.6	1.2	
	8	38.5	0.7	15	9	27	8.2	13.7	49
Copperhead Creek	1	80	0.4	21.7	63	33	9.7	16.3	
	2	19.8	0.3	17.5	71	27	26.2	29.9	
	3	6.2	0.3	15.3	62	34	24.6	40.3	
	4	1.1	0.5	--	70	25	21.7	72.3	51
Egglestron Creek	1	5.8	0.5	--	--	--	15.6	45.5	
	2	3.3	0.8	10.7	18.0	49.0	1.7	5.5	48
Emile Creek	1	34.2	0.7	17.7	6.0	20	1.2	5.4	
	2	10.7	0.1	18.2	2.0	23	13.7	48.2	
	3	8.7	1	--	--	--	16.2	62.2	
	4	84.5	0.5	28.4	65	20	3	9.9	50
Evarts Creek	1	31.8	1.2	7	8	25	2	2.2	
	2	50.3	0.5	--	11	30	9.5	19.9	
	3	32.9	0.6	14.7	29	38	10.7	19.9	56
Fall Creek	1	16.3	0.7	24.5	33	36	1.5	2.3	
	2	11.6	0.6	24.2	32	35	5	12.2	
	3	15.4	0.9	26.1	44	33	12.8	39.4	44

Stream	Reach	% Pool Area	Residual Pool	Width/Depth ratio	% fines in riffles	% gravel in riffles	Large woody debris	Volume of wood	Average Score*
Greenman Creek	1	9.9	0.6	30	25	25	2.2	3.0	
	2	26	0.4	19.4	26.0	15	8.2	15.5	
	3	0	--	--	33	22	4	6.7	39
Jim Creek	1	20.5	.8	41.5	60	13	6.7	8.0	
	2	33	.8	27.5	12	32	9.6	24.7	
	3	37	0.4	23.3	35	23	16.1	23.6	
	4	38.4	0.4	22.4	31	31	17.6	39	
	5	46.8	0.4	18.5	49	31	26	99.7	
	6	48.9	0.3	14.8	43	33	24.2	39.1	58
Little River	1	14.7	1	--	23	32	--	--	
	2	17.1	1.1	--	28	31	--	--	
	3	33.1	1.1	--	36	22	--	--	
	4	24.9	0.6	--	42	34	--	--	44
McKay Creek	1	38.3	0.3	11	63	26	5.8	8.8	
	2	0	0	--	87	13	7.1	17.2	36
Mill Creek	1	9.5	0.3	10.5	34	42	34.8	28.7	
	2	1.1	0.4	20	20	40	31.9	89.2	59
Negro Creek	1	6.8	0.6	--	17	22	13.8	34.2	
	2	5.4	0.6	--	15	26	24.2	62.1	
	3	4.9	0.5	--	19	25	22	33.1	51
Negro trib #1	1	6.3	0.5	--	23	26	29.5	69	
	2	4.9	0.6	--	16	23	33.8	82.1	
	3	18.2	0.5	8.9	57	25	33	60.3	
	4	3.2	0.5	46.7	80	20	16.4	16.5	55
Springer Creek	1	30.7	0.4	23.9	44	21	14	44.9	
	2	22.9	0.2	10.5	60	28	30.3	184.6	56
Tuttle Creek	1	4	0.5	16.5	60	30	22.6	52.8	60
West Fork Wolf Creek	1	18.1	1.7	52.4	24	23	6.5	20.2	
	2	8.9	0.8	29.7	40	31	22.5	68.3	
	3	8.6	0.4	30.7	76	17	12.8	39	50
White Rock Creek	1	26.8	0.3	49	13	18	5.7	5.4	
	2	10	0.2	--	26	36	21.0	53.0	
	3	0	0	--	29	23	6.4	22.7	41
Wolf Creek	1	27.6	0.7	40.7	33	20	5.7	15.6	
	2	20.9	1.5	28.5	16	8	4.6	19.6	
	3	16.7	0.7	42	25	23	14.2	50.2	
	4	3.3	0.7	50	40	20	27.4	19.6	48
Range of values		0 - 84.5	0 - 1.7	7 - 67	0 - 80	8 - 92	0.2 - 34.8	0 - 184.6	36-60

Figure 35. Summary of ODFW 1993 surveys in (lower half of) the Little River watershed. Most streams were divided into reaches for survey purposes. Surveys run from the mouth to the headwaters. The average scores are based upon all of the habitat categories for the entire surveyed length.

Large Wood

Large wood creates pools, stores spawning gravels and fine sediments, and organic material, create habitat, and maintains channel morphology. Obstructions created by large wood help to settle out gravel. The deposition of gravel helps to decrease thermal loading by reducing the amount of water that is exposed to direct solar input, as a portion of the water will travel sub-gravel and not be exposed to solar radiation. In gravel-dominated streams, a large percentage of the flow may travel sub-surface with little opportunity for thermal loading.

The removal of large wood has had the greatest direct impact on stream channel morphology. Once large wood was removed, the alluvial material held behind it washed out, causing channels to down cut and eventually to widen, allowing for increased thermal loading.

Historical accounts recall that streams had "numerous pieces of wood both in and spanning the channel, often making travel and fishing difficult" (Little River Watershed Analysis 1995). In the larger tributaries and main stem, large debris jams often spanned the entire channel providing cover, feeding, and rearing areas for fish.

Large wood was removed for fish passage purposes as well as to protect stream-crossing structures that might be obstructed by the wood and debris (Little River Watershed Analysis 1995). Earlier harvest practices often removed most marketable timber from riparian areas. This included standing trees as well as in-stream wood and downed wood lying within floodplain areas. Wood was also salvaged in these areas during road building activities. Since the early 1900's, fires have largely been suppressed, causing a reduction in the availability of natural downed wood. Current recruitment of new woody debris to the stream channel is slow due to the young age of the riparian vegetation. According to the watershed analysis, 72 to 88 % of the riparian areas within 360 ft. of fish bearing streams in the basin were in a late seral vegetation condition with large conifers and large hardwoods dominating the strands. Today, roughly 30% of riparian stands along fish-bearing streams are considered to have late seral characteristics.

The Oregon Coastal Salmon Restoration Initiative (CSRI) Conservation Plan (1997) developed an in-stream roughness objective:

> *The interim habitat objective for in stream roughness is 50% of the stream length (orders 2-5) will have 4 or more functional key pieces of wood per 100 meters of stream length. A functional key piece of woody debris has adequate length and diameter to be "stable" within a channel.*

Recent observations of the lower Little River recorded from 0 to 67 pieces of large woody debris/mile (Little River Watershed Analysis 1995). A survey along 14 miles of Little River above Wolf Creek found that the frequency of large wood debris averaged 19 pieces per mile. For comparison, Harkleroad (1993) reported finding 50 to 110 pieces of large woody debris per mile in roadless area stream reaches in other watersheds in the North Umpqua basin.

Channel Complexity (pools)

Research has demonstrated that channel complexity, especially slow water habitat, is a major limiting factor regarding fresh water habitat for coho salmon (Dolloff 1986). Pool habitat is an essential habitat element for rearing salmonids. Pools are most productive in combination with large wood, which also provides cover both in the summer and winter and velocity refuges during winter floods. Fish population surveys often find most coho salmon in slow water areas off channel, pools behind beaver dams and channel spanning pools (CSRI 1997). The Oregon CSRI Conservation Plan (1997) has set the following channel morphology objective for State coastal streams:

> *The interim habitat objective for channel morphology is 60% of the stream length (orders 2-5), 35% of the stream area is pool and for 60% of the stream length (orders 2-5), there will be no more than 5-8 channel widths between pools.*

Channel complexity is increased by frequently alternating fast and slow flowing reaches (pools and riffles). Channels that are complex tend to have higher proportions of slow water habitat created by large woody debris, meanders and beaver activity (Meehan 1991). Although no direct links between pools and sedimentation have been found, studies indicate excessive sedimentation may play a role in reducing pool depth and frequency (Lisle and Hilton 1992). Anecdotal observations during stream surveys on the North Umpqua Ranger District have documented reduction in pool volumes as a result of filling with fine sediment. Channel simplification has increased channel width, decreased channel depth and reduced pool size and frequency (Dose and Roper 1994).

The frequency of pools in the Little River and tributary streams has been likely impacted by channel simplification, lack of large woody debris, and sedimentation. Due to incomplete stream survey information, it is not possible to determine the total pool area in the Little River watershed. However, the frequency of pools measured by the number of channel widths separating the pools has been quantified and many stream segments do not satisfy the Oregon CSRI Conservation Plan (1997) channel morphology objective. As channel width increases, streams generally become shallower. It is expected that lower pool frequencies result from increasing these width/depth ratios.

Roads

Road construction throughout the Little River watershed often occurred in riparian areas, frequently adjacent to stream channels. Road construction near streams relies on hardening of stream banks, which can result in channelization of stream segments. Streams that are channelized lack most, if not all, complex habitat indicators (Reiter and Beschta 1995)). Excessive sediment from erosion and mass wasting can accumulate and increase channel width and reduce channel depth resulting in lower pool frequencies. Road construction and maintenance reduces large wood recruitment through continued salvaging along roads.

Aquatic Insects

Aquatic insects are sensitive to changes in aquatic habitat and are often used to assess the quality of habitat conditions. Aquatic insects serve as the primary food source for fish and play an important role in stream ecology. The Forest Service first completed Macroinvertibrate sampling in 1994. Survey results at eight sites indicate that the overall macroinvertebrate community has been moderately impacted (Figure 36). Most species found are considered tolerant to degraded habitat conditions. Many sites recorded the presence of aquatic worm, an indication of excessive sediment. The abundance of snail populations tolerant of poor water quality was attributed to filamentous algae. Upper Cavitt Creek was the only sample site with aquatic insects that ranked moderate to good with few habitat-sensitive species found. However, some tolerant species were found indicating declining habitat and water quality

Many past and some current land use activities such as timber harvest in riparian zones and the removal of in-stream wood have affected aquatic habitat in the Little River watershed. The result of these activities has reduced the recruitment of coarse woody debris. Sedimentation from chronic and episodic surface erosion and mass wasting from roads has likely reduced stream complexity.

Some of the best habitat in the Little River watershed is located along the upper main stem of the Little River where a canyon formed primarily of bedrock outcroppings constrains the river and allows deep plunge pools to form. This provides excellent habitat for steelhead rearing. Tributaries to Little River and Cavitt Creek may also be important rearing and resting areas for fish as the main-stem of Little River and Cavitt Creek become too hot during the summer low flow period. These third, fourth, and fifth order tributaries may become thermal refuge areas. Additional stream surveys would be necessary to determine the amount and type of aquatic habitat in the Little River. Old growth conifers are virtually continuous along these sections of the river and tributaries and are a source of large woody debris and stream surface shade.

Vicinity	Sample Site	Overall Condition of Macroinvertebrate Community
Lower Little River	Near Mouth	**Fair to poor.** Low richness in mayfly: stonefly: caddis fly populations indicates impaired habitat/water quality. Numerous aquatic worms suggest an abundance of fine sediment.
Middle Little River	Above Cavitt Creek	**Fair to poor.** Similar to lower Little River site.
Middle Little River	Near Negro Creek	**Fair.** High richness in mayfly: stonefly: caddis fly populations indicates good habitat/water quality. Also, abundance of tolerant snails, black flies, and crane flies which are tolerant of excessive filamentous algae and/or disturbed enriched streams.
Cavitt	Near mouth	**Fair.** Moderate to low richness in mayfly: stonefly: caddis fly populations, but some highly sensitive species not tolerant of certain degraded habitat conditions also found. Moderate black fly numbers indicate somewhat depressed habitat or water quality.
Cavitt	Upper (above Cultus Creek)	**Moderate to good.** High richness in mayfly: stonefly: caddis fly populations with several sensitive species corresponds to high habitat complexity and integrity. A few tolerant species also found indicating perhaps declining habitat or water quality
Emile	0.35 u/s of mouth	**Fair.** Low richness in mayfly: stonefly: caddis fly populations with only a few sensitive species found. Aquatic worms and dragonflies tolerant of warm water, fine sediment and low dissolved oxygen present.
Black Clover	0.25 mile u/s of mouth of Clover Creek	**Fair.** Low to moderate richness in mayfly: stonefly: caddis fly populations however several sensitive species found that prefer cool water and won't tolerate fine sediments and high winter scour or gravel resorting. Moderate numbers of tolerant caddis flies also found pointing to a general decline in habitat or water quality.
Black Clover	0.25 mile u/s of mouth of Black Creek	**Fair to poor.** Low richness in mayfly: stonefly; caddis fly populations with very few sensitive species found. Moderate numbers of tolerant dragonflies, snails, caddis flies, and aquatic worms. Usually indicative of high summer water temperatures, nutrient enrichment, sediment input and/or low flows.

Figure 36. Summary of US Forest Service aquatic insect samples collected in 1994 (Little River Watershed Analysis 1995).

No formal load allocation is proposed for the habitat modification parameter. Habitat modification is not viewed as a water quality pollutant under the Clean Water Act, however, it may be viewed as an end result of other water quality parameters that have been negatively affected.

Management Actions

Restoration measures include a combination of protective and restorative measures to achieve water quality and fisheries habitat goals. Protective measures can be defined as the cessation of those human activities causing degradation, or preventing recovery of aquatic functions and processes. Restorative measures recover ecological processes and functions.

Protective measures include allowing wood to remain in channels and allowing riparian vegetation to grow to improve large wood recruitment and bank stabilization.

Restorative measures include the placement of in-stream large wood and the re-introduction of fire into the ecosystem to help restore previously existing aquatic habitat. If the problem is too little LWD and too much sediment, priority for restoration measures may be to reduce sediment inputs first and place in-stream structures second (FEMAT 1993). The watershed analysis recommends that in-stream work be addressed after substantial progress is made on restoring upslope processes. The intention is that management action should focus on the causes of the problems rather than the symptoms. Therefore, targets for in-stream wood will not be set. Instead, prescribed fire and placement of wood in streams will be done as opportunities occur and will be based on an assessment of local conditions (where it is likely to historically accumulate, where downed wood is readily available, where habitat is needed, and in stream reaches that are depositional).

Restorative measures to address the temperature and sediment listings will also improve aquatic habitat. Figure 37 provides a summary of habitat elements, affected processes, and management actions. The figure shows that a particular management action can affect numerous processes and that it is important that actions occur in both upland and riparian areas.

Habitat Elements	Affected Process	Management Actions Upland	 Riparian
Water Temperature	Riparian canopy closure		Maintain effective stream buffers, apply silviculture treatments to enhance growth/diversity in riparian plantations
	Sedimentation	Prevent landslides in harvest areas	Decommission/improve roads
	Increased peak flows/channel scour	Maintain canopy closures, decommission/improve roads	Maintain effective stream buffers
	In-stream wood		Add wood to streams, reintroduce fire
Sediment	Landslides	Decommission/improve roads, locate and avoid unstable land	Maintain effective stream buffers
	Road surface erosion	Decommission/improve roads	Decommission/improve roads
	Stream crossing failures	Decommission/improve roads	Decommission/improve roads
	Stream bank erosion	Maintain canopy closures	Add large wood, reintroduce fire
Flows	Bank erosion/channel scour	Maintain canopy closures	Add wood to streams
	Stream extension/road ditchlines	Decommission/improve roads	Decommission/improve roads
Stream Structure	Stream cleanout		Add wood to streams
	Fire	Reintroduce fire	Reintroduce fire
	Bank erosion/ increased peakflows	Maintain canopy closures, decommission/improve roads	Apply silviculture treatments to enhance growth/diversity in riparian plantations
	Riparian harvest		Apply silviculture treatments to enhance growth/diversity in plantations

Figure 37. Habitat elements, affected processes, and potential active restoration options for the recovery of habitat for salmonid fish.

II. Goals, Objectives, and Management Actions

Endangered Species Act, Clean Water Act, NWFP, and Land Management Plans
The Endangered Species Act (ESA) and the Clean Water Act (CWA) are two federal laws which guide public land management. These laws are meant to provide for the recovery and preservation of endangered and threatened species and the quality of the nation's waters. The BLM and USFS are required to assist in implementing these two laws. They provide the overall frame of reference for federal land management policies and plans pertaining to water quality and endangered species.

The Northwest Forest Plan (NWFP) and land management plans are mechanisms for the USFS and BLM to implement the ESA and CWA. They provide the overall planning framework for the development and implementation of this WQRP. The NWFP's Aquatic Conservation Strategy (ACS) was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems on public lands. The NWFP requires federal decision makers to ensure that proposed management activities are consistent with ACS objectives. ACS objectives are listed on page B-11 of the NWFP Record of Decision (ROD). ACS objectives 3-7 contain guidance related to maintaining and restoring water quality. In general, the objectives are long range (10 to 100 years) and strive to maintain and restore ecosystem health at the watershed scale.

The Resource Management Plan (RMP) for the BLM Roseburg District, and the Land and Resource Management Plan (Forest Plan) for the Umpqua National Forest provide for water quality and riparian management and are written to ensure attainment of ACS objectives. These plans contain Best Management Practices (BMP's) which were created to prevent or reduce water pollution to meet the goals of the Clean Water Act.

WQRP Goals
Guided by the relevant laws, policies, and plans as described above there are two goals for this WQRP:

1. Protect existing areas where water quality meets standards and avoid future impairments.
2. Restore existing areas that do not currently meet water quality standards.

WQRP Objectives
The following WQRP objectives result from the laws, policies, and plans described above as well as the analysis of the individual water quality limited parameters as described in Chapter I of this document. On public lands, watershed restoration is critical in aiding recovery of aquatic habitat and water quality. Protective objectives seek to prevent further water quality impairment and restorative objectives seek to reduce existing impairments by restoring habitat to the conditions under which aquatic ecosystems evolved.

Protective objectives:
- Minimize management actions in upslope areas that negatively impact water quality
- Minimize management actions in riparian areas and streams that negatively impact water quality

Restorative objectives:
- Reduce existing and potential sediment delivery to streams
- Reduce road effects on the natural flow regime
- Increase riparian shade to reduce water temperature and pH
- Restore in-stream habitat complexity

Management Actions and Milestone
Management actions are specific actions that lead to the desired long-term conditions. Where appropriate, milestones are included which describe interim targets. Milestones are meant to address the highest existing and

at-risk management-related contributors to water quality problems. The following actions and milestones resulted from the analysis of the individual water quality limited parameters as described in Chapter I of this document. Timelines for accomplishment of milestones are dependent on costs and budget and are therefore discussed in Chapter III.

	Objective	Management Actions (Desired Conditions)	Milestones
PROTECTIVE	Minimize management actions in upslope areas that negatively impact water quality	Future harvesting avoids steep inner gorge, unstable, or streamside areas unless a detailed assessment is performed which shows there is no potential for increased sediment delivery to streams as a result. Consider peak flows and hydrologic recovery when planning timber harvest to maintain appropriate canopy closure.	Ongoing
	Minimize actions in riparian areas and streams that negatively impact water quality	Maintain effective riparian buffers when harvesting timber Future roads are not located in riparian, steep inner gorges, or unstable headwall areas except where alternatives are unavailable. Minimize removal of large wood from channels	Ongoing
RESTORATIVE	Reduce existing and potential sediment delivery to streams Reduce road effects on the natural flow regime	Roads have surface and drainage facilities or structures that are appropriate to their patterns and intensity of use. Unstable landings and road fills that could potentially deliver sediment to a stream are pulled back and stabilized. Culverts are sized to pass 100-year flood and associated sediment and debris. Install cross drains to reduce ditch length at stream crossings No crossings have diversion potential.	Review roads (with medium/high sediment delivery and longest ditch lengths) to verify the need for restoration and treat or decommission as needed. Treat or decommission other roads as indicated in project level planning efforts. Review highest risk stream crossings to verify the need for restoration and treat as needed. Treat other stream crossings as indicated in project level planning efforts.
	Increase riparian shade to reduce water temperature and pH	Increase growth rate in riparian areas through silvicultural practices.	Implement silvicultural prescriptions to meet ACS as determined by project planning prescriptions.
	Restore in-stream habitat complexity	LWD in streams mimics natural conditions. Reintroduce fire into ecosystem.	Place LWD and reintroduce fire based on assessment of local conditions.

Figure 38. WQRP objectives, management actions, and milestones.

Priority Areas for Restoration

In the NWFP, key watersheds provide the refuge areas for maintenance and protection of aquatic populations. With time, species are predicted to re-populate other areas (non-key watersheds) as they begin to recover. Little River was not identified as a key watershed in the NWFP, so it is not currently a top priority for restoration at the Umpqua National Forest and Roseburg BLM District level. However, restorative projects within Little River will be pursued to the extent possible via revenue-generating project funding and grants.

With a refuge strategy in mind, a rating system was developed to select likely refuge sub-watersheds where restoration of aquatic habitat would be most effective. As shown in Figure 39, the best opportunities for focused restoration would be Emile, Wolf Creek, and Cultus Creek. These sub-watersheds have the best water quality, large amounts of contiguous federal lands, and historic diverse fish distribution.

Sub-watersheds	Summer Water Temp	Federal Owner-ship	Diverse Fish Stocks Present	Refuge Potential	Rational/Comments
Watson Mountain	-	-	+	Low	High temps, low federal ownership. Jim Creek 7th field has potential
Red Butte	-	-	+	Low	High Temperatures
Middle Little River	-	-	+	Low	High Temperatures White & Negro 7th fields have potential
Little River Canyon	+	+	+/-	Med	Low fish diversity
Upper Little River	+	+	_	Low	Low fish diversity. Listed as reference basin in W.A.
Emile	+*	+	+	High	Listed as reference basin in W.A.
Wolf	+*	+	+	High	Blocked up BLM ownership
Black	+	+	-	Mod	Low fish diversity
Clover	+/-	+	+	Mod	Low fish diversity
Lower Cavitt	-	-	+	Low	High temperatures, low Federal ownership. Evarts 7th field has some potential
Middle Cavitt	-	-	+	Mod	High Fish Diversity overrides temp & 0wnership. Tuttle Cr. 7th field is W.A. reference basin
Cultus	+	+	+	High	Listed as reference basin in W.A.
Upper Cavitt	+	+	-	Low	Low fish diversity

Figure 39. **Prioritization matrix of potential refuge basins in Little River.** + indicates good conditions for a potential refuge and - indicates less opportunity to function as a refuge. *While Emile and Wolf currently exceed the rearing temperature standard, the have excellent potential to reach the standard with the proposed restoration.

In addition, collaborative restoration efforts between the Roseburg BLM, Umpqua National Forest, Seneca-Jones Timber Company, and the Umpqua Basin Watershed Council are already underway in Cavitt Creek. Middle Cavitt Creek will likely be the focus since it contains a mix of public and private lands.

The Little River Watershed Analysis identified Upper Little River and Clover Creek as sub-watersheds that have substantial existing healthy channel and riparian conditions that are functioning within reference conditions. It is important to continue to protect and maintain riparian conditions in these areas; therefore, these sub-watersheds will also be considered priorities for restoration.

Watershed restoration should address causes of degradation rather than symptoms (FEMAT 1993). While in-stream projects can be an important component of an overall program of restoring fish habitats, these measures are inherently short term (FEMAT 1993). The watershed analysis recommends that in-stream work be addressed after substantial progress is made on restoring upslope processes. In-stream restoration will be accomplished as budgets afford and opportunities arise, but road restoration will be the primary focus for active restoration. Roads affect numerous upslope and in-stream processes such as sedimentation, increased peak flows/channel scour, landslides, surface erosion, stream/road interactions, stream extension, and bank erosion. Road restoration can improve multiple fish habitat elements including water temperature, sediment, stream flows, and stream structure.

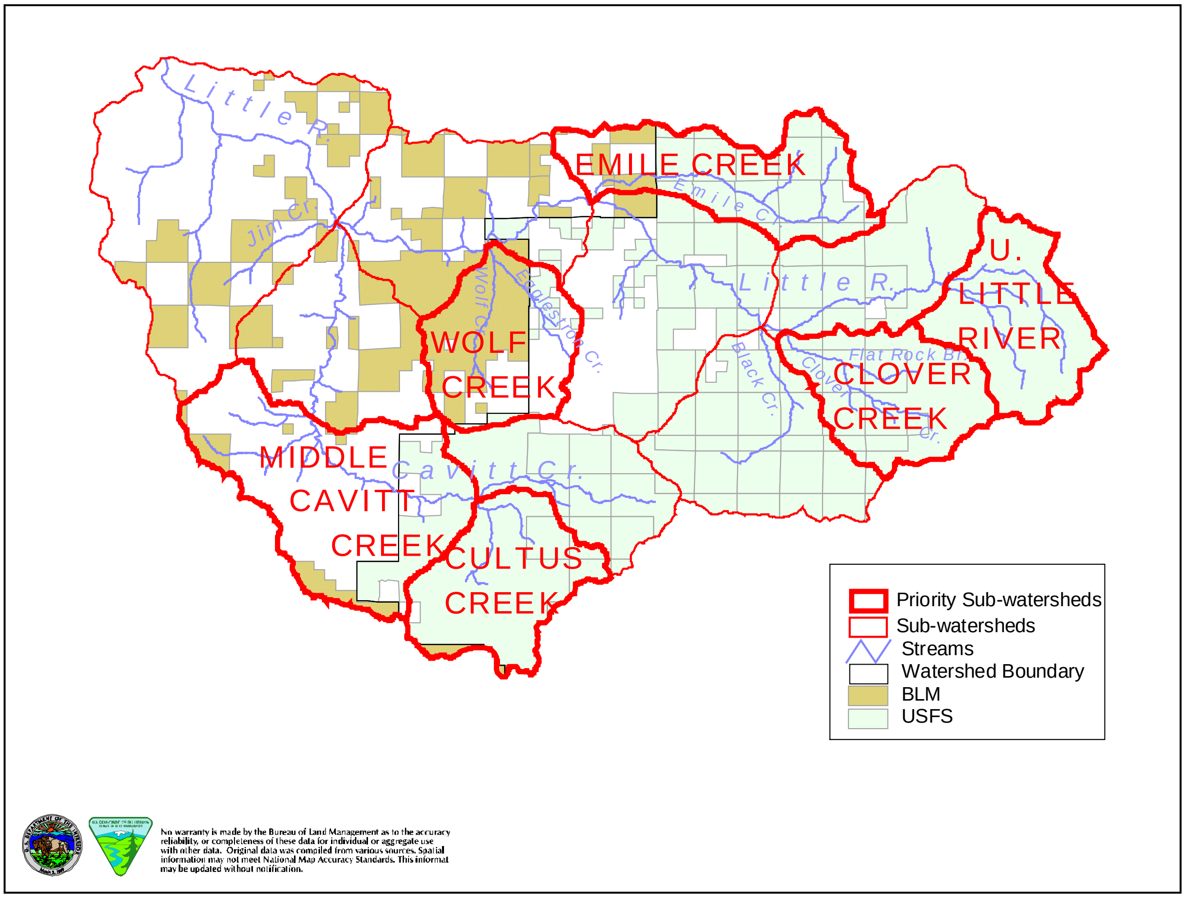

Figure 40. Restoration Priorities in Little River.

III. Time Line for Implementation, Cost, and Funding

Timeline

The problems leading to water quality limitations and 303(d) listing have accumulated over many decades. Natural recovery and restorative management actions to address these problems will occur over an extended period of time. Implementation will be continued until the restoration goals, objectives, and management actions as described in this WQRP are achieved. While active restoration may provide immediate, localized improvement, recovery at the watershed scale is long term in nature. The Aquatic Conservation Strategy contained in the NWFP describes restoration timeframes. ACS seeks to "prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds. Because it is based on natural disturbance processes, it may take decades, possibly more than a century to achieve objectives." It must be noted that 37% of the watershed is under private jurisdiction. While partnerships with private, local, and state organizations will be pursued, the BLM and USFS can only control the implementation of this WQRP on public lands.

Though most of the habitat for anadromous species is located in the main stems of Little River and Cavitt Creeks, much of this habitat is unsuitable for use during the summer months due to high stream temperatures. Lowering stream temperatures in the main stems in both the Little River and Cavitt Creek systems is of critical importance to the long-term survival of salmonids in the basin. Shade modeling indicates natural recovery of riparian growth from past stream-side harvesting is expected to take between 0 and 75 years (see Figure 16). . On public lands, progress over the long term is expected through natural recovery as these riparian areas are now protected from clear-cut harvest. Silvicultural treatments will be applied as appropriate for meeting ACS objectives and will be based on project level planning prescriptions. These treatments may reduce the timeline for achieving target shade levels.

Hydrologic conditions in forest stands will improve on public lands as the NWFP continues to be implemented. Here again, natural recovery will occur and result in a restorative trend in peak flows in select locations. Elsewhere this trend is unlikely to occur.

The recovery of in-stream wood levels is also on the scale of many decades. Naturally occurring fire, an essential mechanism for recruiting wood into streams, continues to be suppressed. Prescribed fire will be applied when possible but is currently too cost prohibitive to be widely used. Recovery will also occur with the re-growth of harvested riparian areas and eventual recruitment of mature and old growth trees into streams.

The existing road system with its unstable cuts and fills, extensive ditch lines, and potential water diversion problems will continue to contribute to sediment delivery and peak flow problems. Here, an active restorative approach is required. The timeline for road-related restoration milestones is 50 years. This is based on the estimated restoration costs as noted above and a planned funding level (from all sources) of approximately $100,000/year. If a higher level of revenue generating activities resumes (than today's level) and/or higher amounts of grant money are secured, this timeline may be accelerated.

Cost and Funding

Active restoration can be quite costly. Costs will vary with the level of restoration but the following are average costs of typical restoration activities (implementation only, does not include planning costs):

Full road decommission:	$26,000/mile
Road improvements:	$40,000/mile
Major culvert removal/replacement:	$55,000/culvert

Following is an estimate of potential restoration costs for accomplishing WQRP milestones:

30 miles of road improvements:	$1,200,000.
68 culvert replacements:	$3,740,000.
10 miles of road decommissioning:	<u>$260,000</u>
Total:	**$5,200,000**

There are several sources of funding for restoration activities. This includes revenue generating activities (such as timber sales), budget line items for restoration, and grants.

<u>Revenue Generating Activities</u>
Traditionally, the main revenue generating activity has been timber sales. Funds from timber sales are used to improve and restore roads associated with the timber sale.

<u>Budget Line Items for Restoration</u>
The Roseburg District BLM, Swiftwater Field Office annual restoration budget (Jobs In The Woods) has averaged $500,000 from FY1995 – FY 2000. The North Umpqua Ranger District annual restoration budget has averaged $250,000. Generally, line item funding is directed to key watersheds. Little River is not a key watershed.

Grants
This includes grant money from federal and state programs such as the Oregon DEQ 319 Non Point Source (NPS) Water Quality program and the Oregon Watershed Enhancement Board (OWEB). Generally, this grant money is intended for organizations involved in improving water quality. The BLM and USFS have been working with the local Umpqua Basin Watershed Council to forge partnerships to complete restoration projects on a cooperative basis.

Work will be accomplished to improve water quality as quickly as possible by addressing the highest existing and at-risk management-related contributors to water quality problems. Every attempt will be made to secure funding for restoration activity accomplishment but it must be recognized that the federal agencies are subject to political and economic realities. Currently, timber harvest is minimal due to lawsuits and the requirements of the clearances needed to proceed. If this situation continues, a major source of funding is lost. Historically, budget line items for restoration are a fraction of the total requirement. Grants may prove to be an increasingly important mechanism for funding restoration but are subject to funding availability and approval of external parties. Therefore, it is important to note that restoration actions are subject to the availability of funding.

Another important factor for implementation time lines and funding is that managers must consider Little River along with all other watersheds under their jurisdiction when determining budget allocations. In the areas of the Umpqua Basin administered by the Roseburg BLM or Umpqua NF, there are 28 5th field watersheds representing 1,369,401 acres that will require WQRP's (Figure 41).

Watershed	Total Acres	Federal Acres	Roseburg BLM	Umpqua NF	Other Federal*
Little River	**131,847**	**82,462**	**19,262**	**63,200**	
Boulder Creek/N.Umpqua River	19,491	19,491		19,491	
Calapooya Creek	157,189	11,956	11,956		
Canton Creek	40,559	30,866	17,689	12,924	253
Clearwater Creek	50,105	50,105	0	50,105	
Elk Creek/S. Umpqua River	54,348	33,409	192	33,125	192
Elk Creek/Umpqua River	187,229	45,095	42,709	0	737
Fish Creek	65,021	65,021	0	65,021	
Jackson Creek	102,329	96,147	0	96,147	
Layng Creek	126,868	96,483	57	86,731	9,694
Lemolo Lake	76,922	76,404	0	76,404	
Lower Cow Creek	102,444	39,943	39,543	0	400
Lower N. Umpqua River	106,190	12,401	12,401	0	
Lower S. Umpqua River	110,417	4,154	4,154	0	
Middle Fork Coquille River	197,060	59,226	19,750	0	39,476
Middle N. Umpqua River	123,911	111,029	11,889	99,140	
Middle S. Umpqua River/Dumont Creek	98,954	86,281	10,566	75,715	
Middle S. Umpqua River/Rice Creek	59,394	7,677	7,677	0	
Myrtle Creek	76,262	31,108	31,005	103	
Ollala Creek/Lookingglass Creek	103,105	27,389	27,389	0	
Rock Creek/N. Umpqua River	62,696	28,434	27,863	142	429
S. Umpqua River	141,450	60,646	57,595	2,487	564
Steamboat Creek	104,673	102,986	0	102,986	
Upper Cow Creek	47,435	33,955	489	24,043	9,423
Upper N. Umpqua River	54,587	54,586	0	54,586	
Upper Smith River	95,551	56,582	25,712	0	30,870
Upper S. Umpqua River	87,046	86,914	0	86,914	
Upper Umpqua River	169,470	58,714	52,337	0	6,377
Totals	2,752,553	1,469,463	**420,135**	**949,266**	100,063

Figure 41. Watersheds in the Umpqua Basin with land administered by the Roseburg BLM or Umpqua NF that require WQRP's. ***Other federal includes Coos Bay, Eugene, and Medford BLM Districts.

The Umpqua National Forest has created a Restoration Business Plan. Little River is currently listed as 4th in priority for restoration. The BLM Roseburg District is developing an overall District restoration plan. Results of the Umpqua Basin Watershed Council's prioritization process resulted in Little River tied for 5th (with 3 other watersheds) on the priority list for the North Umpqua sub-basin. Funding and priorities may change as restoration plans adapt to changing physical, economic, and political factors.

IV. Identification of Responsible Parties

This Water Quality Restoration Plan (WQRP) covers federal lands and was jointly created by the Roseburg District BLM and the Umpqua National Forest with the assistance of Oregon Department of Environmental Quality (DEQ). Both federal agencies will be responsible for implementing the management actions contained in this plan. The federal officials responsible for the creation, implementation, and maintenance of this WQRP are the District Ranger, North Umpqua Ranger District, Umpqua National Forest; and the Field Manager, Swiftwater Field Office, Roseburg BLM.

This WQRP will be submitted to and used by the DEQ in creating an overall Water Quality Management Plan (WQMP) for Little River. The WQMP will cover all land within the Little River watershed regardless of jurisdiction or ownership.

Other organizations or groups that are (or will be) involved in partnerships for implementing, monitoring, and maintaining this plan include the Umpqua Basin Watershed Council, the Little River Committee, U.S. Geological Survey (USGS), Douglas County Natural Resources, Oregon Department of Fish and Wildlife (ODFW), Oregon DEQ, and the citizens of Little River.

Additional discussion of roles and responsibilities regarding plan implementation, monitoring, and maintenance of this effort over time can be found in chapters III, VI, and VIII.

V. Reasonable Assurance of Implementation

Responsible Federal Officials

The North Umpqua District Ranger (USFS) and the Swiftwater Field Manager (BLM) are responsible for ensuring this WQRP is implemented, reviewed, and amended as needed. These officials are responsible for all WQRPs for lands under their jurisdiction. They will ensure coordination and consistency in plan development, implementation, monitoring, review, and revision. They will ensure priorities are monitored and revised as needed. They will review and consider funding needs for this and other WQRP's in annual budget planning.

The two agencies are committed to not only working cooperatively with each other but with all interested parties in the watershed. This includes watershed councils, other government agencies, and private entities. The problems affecting water quality are widespread. We must coordinate activities and seek innovative partnerships to accomplish needed restoration.

The Umpqua National Forest and the Roseburg BLM have jointly developed this WQRP and fully intend to implement this plan within current and future funding constraints. Since 1995, the two agencies have been closely cooperating activities for the Little River Adaptive Management Area (AMA) which covers all federal lands within the Little River watershed. This includes creating a joint AMA Plan and Watershed Analysis along with cooperative project planning and implementation. If implementation problems such as disagreements regarding BMP's or priorities should arise, the two agencies will make a good faith attempt to resolve the disagreements. If this does not succeed, the WQRP will be amended to fully reflect the issue.

VI. Monitoring and Evaluation

Northwest Forest Plan and Federal Land Management Plans

The Northwest Forest Plan (NWFP), The Resource Management Plan (RMP) for the BLM Roseburg District, and the Land and Resource Management Plan (Forest Plan) for the Umpqua National Forest are ongoing federal land management plans. The NWFP became effective in 1994. Federal law requires the RMP and the Forest Plan. The RMP was implemented in 1995 and covers a period of approximately 10 years or until the next RMP is completed. The Forest Plan became effective in 1990 and also covers a period of approximately 10 years or until the next Forest Plan becomes effective. These plans contain extensive requirements for implementation, effectiveness, and validation monitoring of best management practices (BMP's) for water resources. Annual Program Summary and Monitoring Reports provide feedback and track how management actions are being implemented.

Regulations under the National Forest Management Act (36 CFR 219.12, k) require that Forest Plan implementation be evaluated periodically on a sample basis to determine how well objectives have been met, and how closely management Standards and Guidelines have been followed. These monitoring requirements have been incorporated into the Forest Plan. Monitoring serves as the basic tool to evaluate management direction and to determine if there is a need to amend or revise the Plan or to change the way management activities are conducted.

The RMP will be implemented over a period of years. Monitoring will be conducted as identified in the approved plan. Monitoring and evaluations will be utilized to ensure that decisions and priorities conveyed by the plan are being implemented, that progress toward identified resource objectives is occurring, and that mitigating measures and other management direction are effective.

WQRP Monitoring and Evaluation

Monitoring and evaluation will be accomplished within the framework of existing land management plans as described above. There are two major categories of monitoring that will occur for this WQRP. This includes restoration activity accomplishments (did we complete the management action targets) and water quality indicators (did we achieve the desired water quality).

Restoration Activity Accomplishments

As restoration activities are completed they will be tracked by each agency in local databases. This data will be annually provided to the Interagency Restoration DAtabase (IRDA). This database was developed by the Regional Ecosystem Office (REO) to track all restoration accomplishments by federal agencies in the areas covered by the NWFP. It is an ArcView based application and is available via the Internet at the REO website (www.reo.gov). It also contains data from the state of Oregon. The IRDA is intended to provide for consistent and universal reporting and accountability among federal agencies and to provide a common approach to meeting federal agency commitment made in monitoring and reporting restoration efforts in the Oregon Coastal Salmon Restoration Initiative. Activities that are tracked include in-stream structure and passage, riparian treatments, upland treatments, road decommissioning and improvements, and wetland treatments.

In addition, implementation and effectiveness monitoring will be accomplished for restoration projects according to project level specifications and requirements.

Water Quality Indicators

Water quality indicators are critical for assessing the success of this WQRP. This data will be used to monitor the success of plan implementation and effectiveness. Ongoing monitoring will detect improvements in water quality conditions as well as progress toward reaching the water quality standard. The core indicators of water quality and stream health that will be monitored are:

- Water Temperature
- Stream Flow
- Macroinvertibrates
- Stream Surveys
- Stream shade
- pH
- Pebble counts, Core Sampling

Water Quality Parameter	Indicator	Frequency
Water Temperature	Temperature <= 64° (7) day moving average of the daily maximum for rearing (6/1-9/30) Site Potential Stream Shade Stream Flow	Annually 5 years Annually
pH	pH within a range of 6.5 – 8.5	Annually
Sediment	Macroinvertibrates <=60% impaired Pebble Counts Core Sampling	Annually Annually TBD
Habitat Modification	Stream Surveys show PFC* or good rating	10 years or TBD

Figure 42. Water quality indicators for the Little River watershed. *Proper Functioning Condition

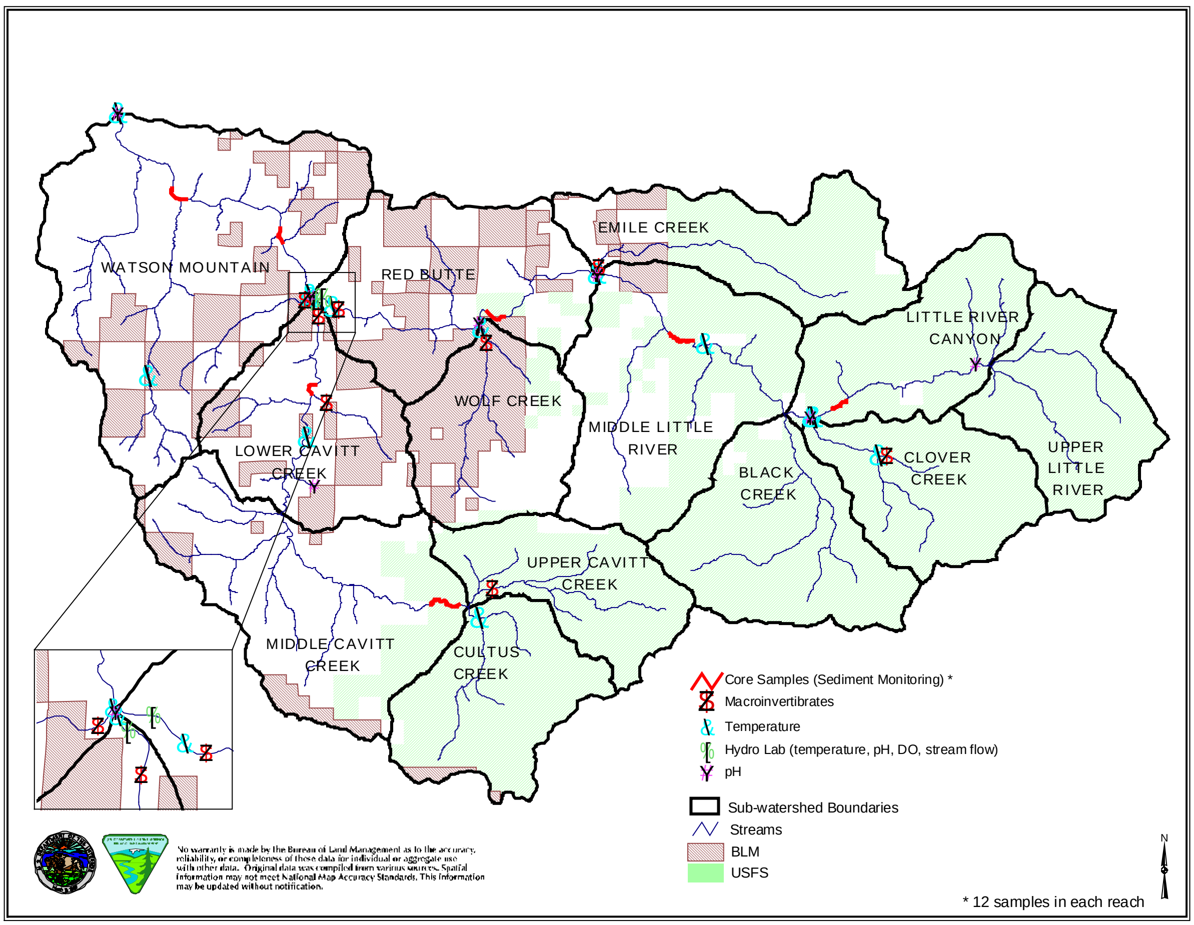

Figure 43. Location of USFS and BLM water quality monitoring sites.

Water Temperature
The BLM and USFS have collected stream temperature data since 1994 and will continue to monitor stream temperatures in order to detect any changes in temperature from long-term data sets. Sampling methods and quality control will follow ODEQ protocol. Several long term monitoring sites as well as project-specific, short-term sites will be used. Core long-term sites that will be monitored annually include:

BLM:	Mouth of Cavitt Creek, Egglestron Creek, Emile Creek, Fall Creek, Lower Jim Creek, Little River (above Wolf Creek), Wolf Creek above Egglestron
USFS:	Cultus Creek(mouth), Clover Creek (mouth), Little River (above Clover Creek), Flat Rock Branch, Little River (below White Creek)

The USGS collects and publishes stream flow information. Stream flow was continuously monitored on Little River above Peel, OR until 1989 when the gauging station was discontinued. As a result of recommendations in the watershed analysis, this station was re-established in 1999 through a joint funding initiative by the BLM and USFS. Numerous other sites have been monitored by the USGS in the past and historical data is available on the Internet (www.usgs.gov). Stream low flows are also measured during annual temperature monitoring.

Stream shade will be monitored in selected reaches where there are long-term temperature monitoring sites to help review progress towards meeting the temperature standard and shade targets.

pH
Data on pH was collected in 1994 in support of the Little River watershed analysis and again in 1995 to verify the 1994 results. The USFS and BLM jointly fund two hydrolabs in Little River and Cavitt Creek that collect pH data (along with a number of other parameters).

It was determined by Oregon DEQ that additional information was needed to develop a TMDL for pH. Equipment was deployed the week of August 28, 2000 to collect data for a continuous 24-hour period on temperature, Dissolved Oxygen, pH, conductivity, and dissolved solids. In addition, readings for alkalinity, nutrients, and BODs were taken. Data was collected at the following locations:

BLM:	Little River (mouth), Little River (above Wolf Creek)
BLM & USFS:	Little River (river mile 8)*, Cavitt Creek (just upstream of Little River confluence)*
BLM & DEQ:	Little River (above Emile Creek)
DEQ:	Little River (below Clover Creek), Little River (below Pinnacle Creek), Cavitt Creek (0.7 river miles upstream of Buckshot Creek)

*Each Hydrolab site is monitored annually for at least 24 hours during summer low flows.

Sediment*
Macroinvertibrates (aquatic insects) will be the primary tool used to monitor how impacted aquatic life is responding to changes in stream habitat. Sampling was completed by the USFS in 1994, 1997 and 1999. The BLM developed a long term monitoring plan in 2000 and sampling will be conducted annually according to DEQ protocols. Long term monitoring sites include:

BLM:	Wolf Creek, Jim Creek, Evarts Creek, Flat Rock Branch of Clover Creek
USFS:	Lower Cavitt Creek, Upper Cavitt Creek, Emile Creek, Middle Little River

Limited data on in-stream sediment has been collected. Several techniques have been used to monitor sediment in streams. The BLM performs a pebble count when taking macroinvertibrate samples. Results will be reviewed to assess changes in particle size. The USFS performed core sampling (using a mechanical device to take a core from stream) in 1995 at a cost of $11,800. This data is currently being analyzed. Other available techniques include grid toss, embeddedness, substrate scoring, and V* Pool Index. The cost and labor involved with the various techniques range from minimal (pebble counts, grid toss, embeddedness, substrate scoring) to significant (V* and core samples). Critical considerations for the timing and placement of sampling include examining the effects of sediment on fish spawning, rearing, and food production. In FY2001, the BLM and USFS will review current methodology, timing, sampling frequency, numeric targets, and sites to determine if any changes should be made.

Habitat Modification

Stream survey data (pools, LWD, substrate, width/depth ratio, etc…) has been collected by the BLM and USFS. The BLM contracted with ODFW to complete stream surveys on 79 miles of streams in the lower half of the Little River watershed in 1993. The USFS uses an agency-specific protocol and completed stream surveys on 60 miles of stream in 1994. Due to the difference in protocols, the two data sets are not directly compatible. These surveys are quite costly (up to $1,000/mile) and time consuming. Some elements of the surveys may not be repeatable due to subjective ocular measurements. Due to these issues, stream habitat surveys are valuable as a snapshot in time but may not serve as a good monitoring tool. Currently, the Umpqua National Forest Land and Resource Management Plan provides for these surveys to be completed at 10-year intervals. The BLM does not currently have plans to repeat them. The two agencies will continue to evaluate the applicability and value of this methodology as a monitoring tool.

Monitoring Data and Adaptive Management

Currently, USFS and BLM hydrologists meet quarterly to review water quality data collection. These meetings will continue and will be framed in the context of reviewing the requirements of this WQRP. Data will be normalized and summarized annually and posted to the Little River AMA website (www.teleport.com/~lrama).

This WQRP is intended to be adaptive in nature. Sampling methodology, timing, frequency, and location will be refined as appropriate based on lessons learned, new information and techniques, and data analysis. A formal review involving USFS, BLM, and DEQ will take place every five years to review the collected data and activity accomplishment. This ensures a formal mechanism for reviewing accomplishments, monitoring results, and new information.

**It is also important to note that a rotary-screw smolt trap located in Little River, approximately 5-6 road miles from its confluence with the North Umpqua River, was operated from 1995 - 2000. It was used to trap, identify, and count fish migrating from Little River. Data from this smolt trap were used in the Watershed Analysis to describe the early emergence of sac-fry (possibly due to high levels of fine sediment in spawning gravels). This trap has been discontinued due to lack of funding and personnel. In addition, due to confounding factors (variable water flow, in-trap predation, bed instability during high flow) smolt trap data on sac-fry emergence is not a good sediment monitoring method. Other methodology provides a better indication of stream sediment loading.*

VII. Public Involvement

Northwest Forest Plan

This WQRP is a comprehensive plan for addressing water quality using elements of the Northwest Forest Plan (NWFP). It tiers to and appends the Little River Watershed Analysis. Watershed analyses are a required component of the Aquatic Conservation Strategy (ACS) under the NWFP. The Record of Decision (ROD) for the NWFP was signed in April of 1994, following extensive public review.

Public Land Management Plans

The USFS and BLM are responsible for creating and implementing public land management plans for lands under their jurisdiction. The plans are required to comply with the Clean Water Act and state environmental protection programs. These plans fully address water quality.

The Roseburg Resource Management Plan (RMP) and Record of Decision (ROD) for the BLM Roseburg District were approved on June 2, 1995 after extensive public review. The ROD shows how environmental impacts and other factors were considered in the decision making process. The Governor of Oregon was provided formal opportunity to review the proposed plan. There were no objections from the Governor.

The Land and Resource Management Plan (Forest Plan) for the Umpqua National Forest became effective on October 5, 1990 after extensive public review.

Both agencies issue periodic monitoring reports that describes progress on plan implementation.

Water Quality Restoration Plan

During the planning effort, the BLM referenced this WQRP in quarterly planning updates which are provided to the public. The WQRP was widely distributed for review prior to finalizing. This included review by USFS and BLM regional and Forest/District personnel and the Oregon Department of Environmental Quality. The draft plan was also posted to the Little River AMA website.

Water Quality Management Plan

The Oregon Department of Environmental Quality (DEQ) has lead responsibility for creating Total Maximum Daily Loads (TMDLs) and Water Quality Management Plans (WQMP) to address water quality impaired streams for Oregon. This WQRP will be provided to the DEQ for incorporation into an overall WQMP for the Little River watershed. DEQ has a comprehensive public involvement strategy, which includes informational sessions, mailings, and public hearings. The USFS and BLM will provide support and participate in this public outreach.

VIII. Maintenance of Effort Over Time

The problems leading to water quality limitations and 303(d) listing have accumulated over many decades. Management measures to address these problems will be carried out over an extended period of time. Furthermore, once restorative actions and new practices achieve desired results, continued vigilance will be required to maintain water quality standards.

Northwest Forest Plan and Federal Land Management Plans

The Northwest Forest Plan (NWFP), The Roseburg Resource Management Plan (RMP), and the Land and Resource Management Plan (Forest Plan) for the Umpqua National Forest are ongoing federal land management plans. The NWFP became effective in 1994. Federal law requires the RMP and the Forest Plan. The RMP was implemented in 1995 and covers a period of approximately 10 years or until the next RMP is completed. The

Forest Plan became effective in 1990 and also covers a period of approximately 10 years or until the next Forest Plan becomes effective.

Water Quality Restoration Plan

The North Umpqua District Ranger (USFS) and the Swiftwater Field Manager (BLM) working in partnership with the DEQ are responsible for ensuring the WQRP is implemented, reviewed, and amended as needed. This includes the following:

1. Review of the activities of the responsible agencies to determine if implementation is occurring as planned. If it is not, determine the reason and revise the plan as necessary.
2. Promotion of ongoing communication, financial support, and partnerships for implementing priority projects.
3. Continue efforts to explore revised or additional management measures based on results of monitoring activities and other sources of information.
4. As additional information becomes available and techniques are improved, continue to improve and revise cost/benefit estimates.

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